New Scientist

WEEKLY 13 January 2024

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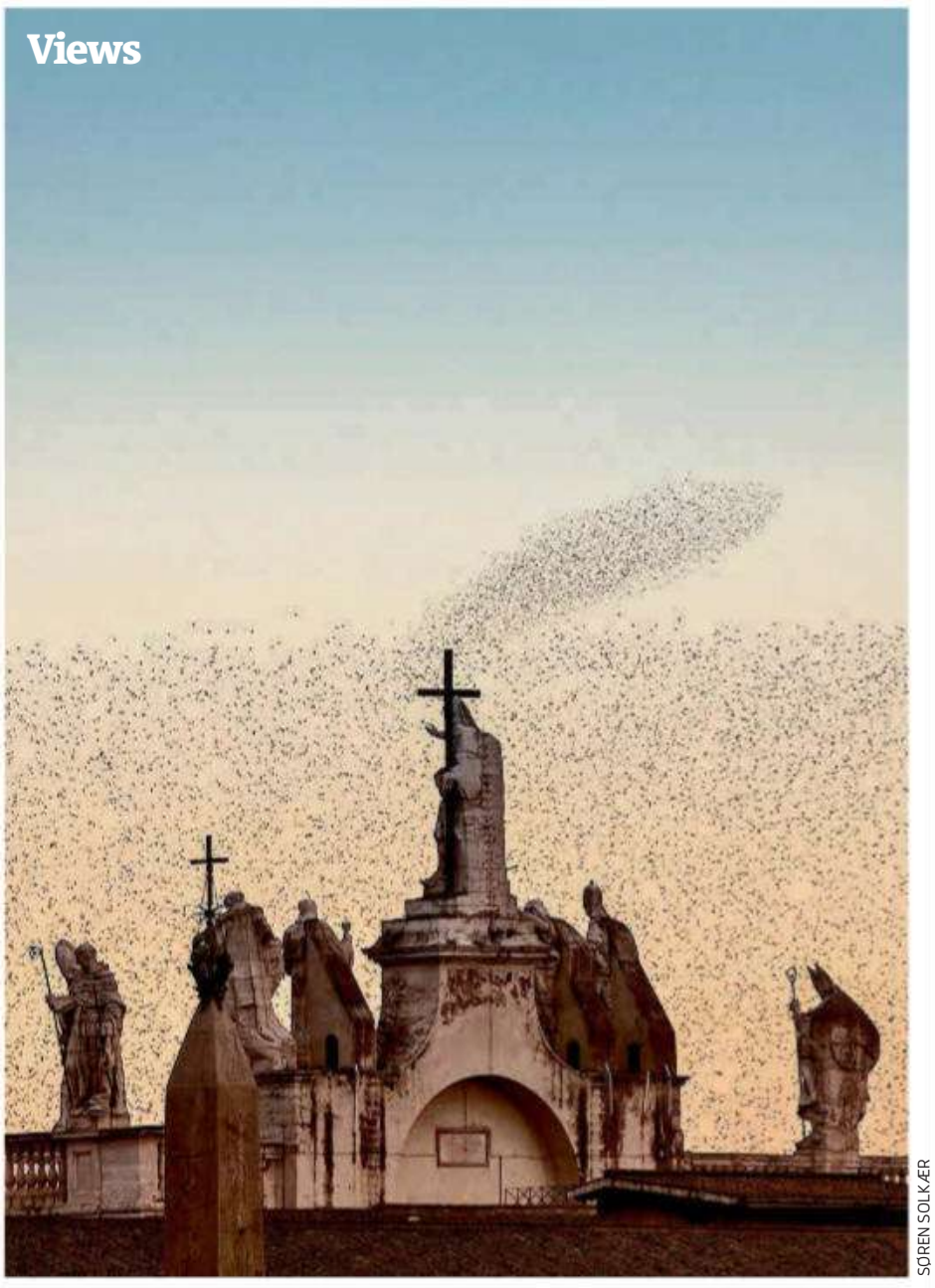

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Virtual event

The dark side of the universe

Hear cosmologist Katherine Freese recount stories from her book *The Cosmic Cocktail: Three parts dark matter*, from historic discoveries to the deluge of data from underground labs, space satellites and particle accelerators. Learn whether we are close to solving the mystery of what glues galaxies together in this online talk at 7pm EST on 21 February/ 12am GMT on 22 February.

newscientist.com/events

Tour

Tasmania's flora, fauna and geology

The Australian island of Tasmania boasts golden beaches, misty mountains and lonely patches of wilderness. Join biologist and conservationist Martin Cohen in seeking out Tasmanian devils, platypuses and fairy penguins. Wander among ancient geology and discover the island's Indigenous cultures. This 12-day tour begins on 20 February and tickets cost £4595.

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Podcast

Weekly

What exciting or sobering trends do *New Scientist*'s reporters expect to continue covering in the year ahead? And what surprising innovations are they keeping their eyes out for? Find out in this 2024 preview covering record global temperatures, the soaring popularity of weight-loss drugs and new horizons for quantum computers and cryptography.

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JENS SCHLUETER/DDP/AFP VIA GETTY IMAGES

Jane Goodall There is still time to change our relationship with nature

SHUTTERSTOCK/HELENFIELD

Year of the moon What to make of the next spate of lunar missions

Video

Wild optimism

Renowned conservationist Jane Goodall talks to *New Scientist* writer Graham Lawton about her hopes for the youth of today and why she thinks we can still turn the tide against climate change. "I truly believe that we've got a window of time to make a change – but it's closing," she says. "When nature suffers, we all suffer. When nature flourishes, we all flourish."

youtube.com/newscientist

Newsletter

Launchpad

Space reporter Leah Crane unpacks why she is wary that we are ramping up the pace of lunar excursions. The moon holds an invaluable record of the solar system's teenage years, yet many of 2024's planned missions to it are geared towards human space exploration rather than planetary research.

newscientist.com/launchpad

Podcast

"It looks like a computer that can crack quantum encryption is on the way"

Essential guide

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The great moon rush

A flood of lunar missions will be a boon for science, but we must proceed with care

THIS is the year of the moon, and it is already kicking off. The first launch of the Vulcan rocket on 8 January marked the start of what may be the biggest deluge of missions the moon has ever seen, thanks to NASA's Commercial Lunar Payload Services (CLPS) programme (see page 7).

The first CLPS mission is Astrobotic's Peregrine lander, an uncrewed craft lofted on Vulcan that hoped to reach the lunar surface on 23 February. It could have been the first time a private firm touched down on the moon, but Peregrine suffered a fuel leak and won't now make it to its intended destination. Nevertheless, there are more such missions planned this year, with the world's space agencies and firms determined to make it to the moon.

In the midst of all this robotic exploration, preparations are also afoot to have humans land there as well, a feat that hasn't been accomplished since 1972. NASA's Artemis II mission, planned for the end of the year, will take four astronauts around the moon, including Christina Koch, the first woman to travel to Earth's satellite (see interview, page 41). If it goes well, this will be the last dress rehearsal for the return of astronauts to the lunar surface.

"The moon could be said to be entering a new geological era akin to the Anthropocene"

That surface, free from the influences of geological and biological activity, can give us crucial details not just about Earth's past, but about the evolution of the entire solar system. Plus, it is an important jumping-off point for any journeys further afield. The technologies for those missions will have to be tested somewhere, and the moon, with all its similarities to Mars and other relatively small worlds, is arguably the best place for doing so.

Still, with so much activity on the lunar surface that it could be said to be entering a new geological era akin to the Anthropocene (see book review on page 29), we should proceed with care to avoid despoiling it. Our moon is a pristine time capsule from our planet's past and a reminder of the way our world has changed through our actions. To not learn from our mistakes would be unforgivable. ▮

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Space

Vulcan launches

NASA's first attempted mission to the lunar surface since the Apollo missions in the 1970s began with the launch on 8 January of a Vulcan rocket carrying a robotic lander. Unlike previous NASA missions, the new efforts will be public-private partnerships. But the mission is doomed because the Peregrine lander from space firm Astrobotic experienced a fuel leak that means it won't reach the moon.

CRISTOBAL HERRERA-ULASHKEVICH/EPA-EFE/SHUTTERSTOCK

Palaeontology

Giant ape's extinction explained

We now know more about why the mysterious *Gigantopithecus blacki* died out up to 295,000 years ago, after failing to adapt to a changing climate, reports **James Woodford**

THE largest known primate went extinct between 295,000 and 215,000 years ago, probably driven by its inability to adapt its food preferences amid a changing climate.

A relative of today's orangutans, *Gigantopithecus blacki*, known as "Giganto", was 3 metres tall and weighed up to 300 kilograms. Despite surviving for more than 2 million years, the species has been a bit of an enigma since its fossilised tooth was found in a traditional medicine shop in Hong Kong in 1935. The enormous tooth was initially purported to belong to a dragon, but palaeontologists quickly recognised it was, in fact, from a primate.

"When you think about them, you think about giants," says Kira Westaway from Macquarie University in Sydney, Australia. "Normally when you think about a giant, you think about a dinosaur, but this was a giant in the primate family."

GARCIA/JOANNES-BOYAU (SOUTHERN CROSS UNIVERSITY)

KIRA WESTAWAY/MACQUARIE UNIVERSITY

Pollen and sediment in caves (above) suggest the largest ape on Earth lived in grassy areas, as illustrated (left)

Failure to adapt

To establish a timeline for when the ape went extinct, Westaway and her colleagues studied hundreds of its teeth and four jawbone fragments found in caves across Guangxi province in southern China. Looking at the radioactive decay of certain elements, such as uranium, within teeth and bone allows researchers to gauge how much time has passed since death.

They also looked at other deposits, such as pollen and sediment, within the caves to determine the conditions that *G. blacki* – a herbivore – lived in.

"We show that, from 2.3 million years ago, the environment was a mosaic of forests and grasses, providing ideal conditions for thriving *G. blacki* populations," the researchers write. "However, just before and during the extinction window between 295,000 and 215,000 years ago, there was enhanced environmental variability from increased seasonality, which caused changes in plant communities and an increase in open forest environments," they add (*Nature*, DOI: 10.1038/s41586-023-06900-0).

By studying banding in the animals' fossilised teeth, the researchers detected signs of chronic stress caused by a lack of availability of their favourite food. Being unable to adapt to a shifting climate, and the food variability that came with it, probably sealed the creature's fate, they say. In contrast, orangutans, of which there are three surviving species, adapted their dietary preferences and behaviour in response to increasing climate variability.

"Ultimately [*G.blacki*'s] struggle to adapt led to the extinction of the greatest primate to ever inhabit the Earth," the researchers write. They also dispel the idea that hominins may have competed with or hunted the species, helping to drive its demise. "There is no evidence for this," says Westaway.

Julien Louys at Griffith University in Queensland, Australia, says the researchers present a convincing case that changing environments, and particularly increased habitat variability, probably had detrimental effects on *G. blacki*.

He adds, however, that the fossils studied came from a quite restricted geographical region. Fossils resembling *G. blacki* have also been found in Thailand, Vietnam and Indonesia.

"One thing seems almost certain: their actual geographical range through time would have been much greater than current fossils indicate," says Louys. "How much this will affect the timing of the global extinction of the species is impossible to tell."

295k
Maximum years since extinction of *Gigantopithecus blacki*

215k
The minimum number of years since the primate died out

2 million
The total span in years over which *G. blacki* roamed Earth

Fossil shortage

Anne-Marie Bacon at the French National Centre for Scientific Research says that the study helps us to understand *G. blacki*'s extinction, but just studying fossils from China only reveals part of its history.

"This paper focuses on Chinese records, but due to the scarcity of palaeontological sites in Asia, we don't know if the geographical range of the giant ape extended on the Indochinese peninsula [mainland South-East Asia], and, furthermore, what was the southernmost limit of this range," she says. ▮

Technology

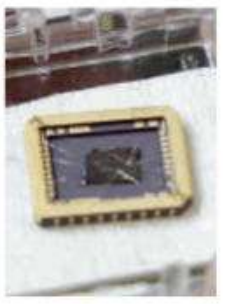
First working graphene semiconductor could lead to faster computers

Matthew Sparkes

A WORKING semiconductor has been created from graphene, potentially paving the way for a new type of computer with greater speed and efficiency than today's silicon chips allow.

Graphene is a material made from a single layer of carbon atoms that is stronger than steel at comparable thicknesses. It is a good electrical conductor and is resistant to heat and acids. But a working graphene semiconductor, which can be controlled to conduct or insulate electricity at will, has evaded scientists. Such semiconductors are key to creating the logic chips that power computers.

The problem has been the lack of what is known as a bandgap. Semiconductors have bands of higher and lower energies and a point – the bandgap – at which excited electrons can hop from one to the other. This effectively allows the flow of current to be switched on and off, so it is either conducting or not conducting, creating the binary system of zeroes and ones used in digital computers.



GEORGIA INSTITUTE OF TECHNOLOGY

A graphene semiconductor, grown on a silicon carbide wafer

While previous research has shown that graphene can be made to act like a semiconductor on a small scale, it had never been scaled up to sizes that would make a computer chip practical.

Now, Walter de Heer at the Georgia Institute of Technology in Atlanta and his colleagues have created graphene with a bandgap and demonstrated a working transistor, an on/off switch that either prevents or allows current to flow through it. Their process should be conducive to scaling up because it relies on techniques not dissimilar to those used to create silicon chips.

De Heer's group used wafers of silicon carbide that were heated, forcing the silicon to evaporate before the carbon, effectively leaving a layer of graphene on top (*Nature*, doi.org/mbzf). De Heer said in a statement that the electrical properties of a graphene semiconductor were far better than those of silicon chips. "It's like driving on a gravel road versus driving on a freeway," he said.

Silicon chips are cheap to make and backed by massive manufacturing infrastructure, but we are reaching the limits of what they can do. Moore's law states that the number of transistors in a circuit will double roughly every two years, but the rate of miniaturisation has slowed recently as engineers reach circuit densities beyond which electrons can't be reliably controlled.

"The fact they're using wafers is important because that's really, truly scalable," says David Carey at the University of Surrey, UK. "You can use all the technology that the whole semiconductor industry is totally comfortable with to scale up this process." But he is sceptical that the world will soon shift to graphene chips, because silicon has such a head start. "Most people who work on silicon are bombarded on a daily basis by new, wonderful materials that are about to replace it and none of it's ever happened," he says.

"Using graphene instead of silicon is like driving on a gravel road versus driving on a freeway"

Climate change

2023 was officially the world's hottest year on record

LAST year was the hottest ever recorded. The global average temperature for the year was 1.48°C warmer than the 1850-1900 pre-industrial average, according to the European Union's Copernicus Climate Change Service (C3S). That is the highest since records began in 1940 and probably the highest in 100,000 years, sparking heatwaves, droughts and wildfires.

The year's average temperature of 14.98°C (58.96°F) came close to hitting 1.5°C above pre-industrial times, a limit that countries are aiming to avoid under the 2015 Paris Agreement – although the goal applies to the long-term average temperature rather than the average for a single year.

"The extremes we have observed over the last few months provide a dramatic testimony of how far we now are from the climate in which our civilisation developed," said Carlo Buontempo, the director of C3S, in a statement. "We need to urgently decarbonise."

In a first, every day of the year was at least 1°C warmer than its equivalent in pre-industrial times. Richard Betts at the Met Office, the UK's national weather service, says 2023 was even more scorching than expected. That is partly because El Niño, a natural climate phase that boosts temperatures, started earlier in the year than usual, although most of the warming is still due to human emissions.

PATRICK T. FALLON/AFP VIA GETTY IMAGES

A billboard displays 118°F (47.8°C) during a heatwave in Phoenix, Arizona, in July

"The Met Office makes predictions on the forecast for the coming year every year," says Betts. "2023 was the first time it was substantially above what we would predict."

The sweltering temperatures made extreme weather like the heavy rains of Storm Daniel, which breached dams and killed more than 11,000 people in Libya last September, much more likely. The July heatwave in North America and Europe would have been "virtually impossible" without climate change, the World Weather Attribution initiative said in a report.

Ocean temperatures were also unprecedented in 2023, according to C3S, and contributed to events like Hurricane Otis, which intensified more in 12 hours than any storm in history.

This year will also be hot and could even break 2023's record, says Betts.

Alec Luhn

Astrophysics

A way to solve the black hole paradox

We may be able to measure "islands" that contain copies of information that black holes have lost

Alex Wilkins

WE MAY be able to find out what happens to matter that falls into a black hole, something previously thought impossible. This is because some parts of a black hole's interior, called islands, may actually poke far enough out of the hole for us to measure them. If we can do this, then Stephen Hawking's black hole paradox might finally be resolved.

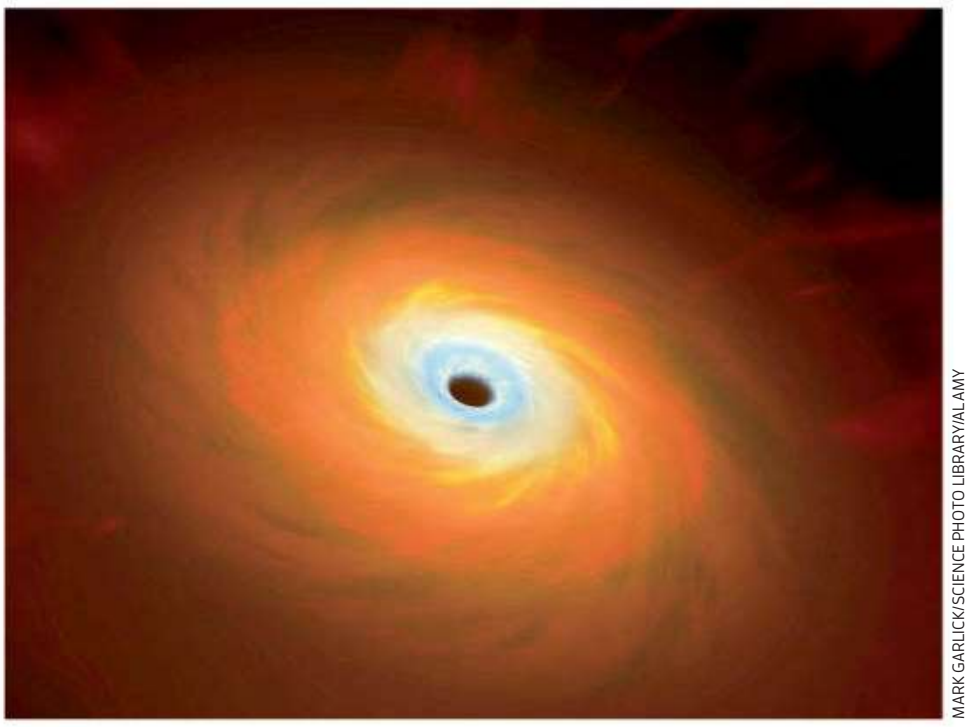
"There's some extremely surprising physics that is no longer hidden behind black hole horizons"

In the 1970s, Hawking realised that when the laws of quantum mechanics are applied to the sphere around a black hole where light can no longer escape, called its event horizon, then radiation should be emitted by the black hole. This means the black hole slowly "evaporates".

This Hawking radiation, which contains only some of the information of whatever is sucked in by a black hole's gravity, will eventually cause the black hole to totally evaporate, which creates a paradox. In physics, information can't just disappear, but if something falls into a black hole and the Hawking radiation only contains some of the information about it, then when the black hole evaporates, some information would be lost forever.

Competing ideas

Physicists have come up with many ideas to resolve the paradox, but the most popular ones focus on what happens to the Hawking radiation after it is created. An approach called complementarity says that the lost information is actually stored at the black hole's boundary while also passing through to its interior, appearing in different ways to an observer depending on whether they have fallen into the black hole or remain outside.



MARK GARLICK/SCIENCE PHOTO LIBRARY/ALAMY

Nothing escapes a black hole's gravity, but we may be able to detect what is going on in one

Although this appears to create two "copies" of the information and violate a key principle of quantum mechanics called the no-cloning theorem, these copies are actually just different viewpoints, described in Albert Einstein's theory of relativity, so that no single observer could see both copies at the same time.

However, in 2012, a group of researchers found black hole scenarios in which this complementarity would, in fact, lead to an observer being able to access both copies at the same time, again violating the no-cloning theorem. These researchers proposed that there was actually an incredibly hot "firewall" around the black hole's event horizon that would destroy everything on contact, again separating the two copies.

Physicists have argued over which interpretation is correct for more than a decade, and settling the matter via experiment seemed impossible as it would require sending a person or instrument past the black hole's event horizon, which is, by definition, inescapable.

But, in 2019, researchers found that for some specific simplified hypothetical black holes, some information about the interior might be detectable on the surface of the event horizon, in a so-called entanglement island.

At the event horizon of a black hole, you have virtual particle pairs popping in and out of existence. If one of these quantum entangled pairs is split up by the event horizon, then one will be held in the black hole and the other will fly out as Hawking radiation.

"You can do this observation of a black hole without dying, in some sense"

The entanglement islands, if we could measure them, would reveal what happens to the "prisoner particles" and the seemingly duplicated information that would exist if complementarity is right.

Tantalisingly, researchers found these surfaces could even extend slightly beyond the event horizon, but the distance they poked out appeared to be smaller than the tiniest possible length we can measure physical effects on, which made islands seem like more of a mathematical curiosity than a physical reality.

Now, Raphael Bousso and Geoff Penington at the University of California, Berkeley, have calculated that for more complicated black holes, like the ones that actually exist, the islands can extend even further outside the black hole's event horizon. For a supermassive black hole, this could be by as much as an atom's length, which raises the prospect of measuring one (arXiv, doi.org/mb3w).

"We show these islands actually protrude beyond the horizon of the black hole far enough that, in principle, there is no obstruction to probing them and coming back out," says Bousso. "That's actually pretty dramatic because it means that there's some extremely surprising and radical new physics that is no longer hidden behind black hole horizons or hits you when you try to jump into a black hole, but which is, in principle, accessible to us."

Getting a scientific instrument within an atom's width of a black hole horizon would require far more advanced technology than we currently have, because the gravitational pull is so strong. The closest black hole that is massive enough to have a potentially detectable island is thousands of light years away. But, says Bousso, "with futuristic technology, the laws of physics don't prohibit you from probing it".

"You need to get within about the size of an atom from its

horizon and then get back out again. That's pretty hard to do. Like really, really hard to do," says Penington. One way this could be made easier is if the black hole itself were electrically charged, which is theoretically possible, but unlikely given that the universe is electrically neutral. You could then make your spaceship the opposite charge to the black hole, which, assuming you could get it close enough in the first place, could then propel your ship away again.

If the probe is vaporised before it gets to the event horizon from something other than an obvious physical effect resulting from radiation or gravitational tidal forces, then this would show the firewall interpretation is correct, says Penington. If the probe returns unscathed, then it would show that complementarity is probably correct.

Being able to differentiate between complementarity and a firewall would be an important development, says Juan Maldacena at the Institute for Advanced Study in Princeton, New Jersey, even though he isn't convinced we would be able to measure a physical black hole.

"You are not going to be able to do it for a realistic black hole, but one might be able to do something similar for toy black holes that you can make in a laboratory," says Maldacena. "You can do this observation without dying, in some sense."

One way would be to simulate one on a quantum computer, which Maldacena, in a separate work, has calculated would require about a million quantum bits, or qubits, some way beyond the 1000 qubits of today's best quantum computers. However, it may be possible to test for these islands in simpler models that require fewer qubits, he says. ▮

Environment

Grinding bones into an edible paste could reduce food waste

James Dinneen

THEY looked, smelled and tasted like your average fish balls, but the salmon snacks served on crackers in the *New Scientist* test kitchen were made with a large share of ground-up bones. Don't be surprised if your next chicken nugget or fish stick is stuffed with edible bones too.

A Finland-based start-up firm called SuperGround has developed a way of pulverising fish or chicken bones into a nutritious paste that can be added to meat products. Two large seafood processing companies, Kalavapriikki and Royal Greenland, started testing paste made this way in some of their products in late 2023.

"It's always better to eat everything you can eat," says Santtu Vekkeli, founder of SuperGround. Consuming bones along with meat uses more of the animal, making it a more efficient way to produce food. And yet, he points out, huge quantities of bones go to waste.

Many cultures use bones to make broth or eat softened bones as part of their meals, but in Europe and North America, deboned meat is the norm, and Vekkeli says few people spend hours making their own broth. Instead, lots of these "hard parts" end up in landfills: the world's more than 20 billion broiler chickens leave behind so many bones that their remains serve as a potential marker of the Anthropocene – the age of planetary change due to humans.

"I have dreamt of using bones," says Joe Regenstein at Cornell University in New York. Many large bones are used as a source of collagen for gelatine, and smaller ones are put in animal feed and fertiliser, but he says this is less efficient than eating them directly. Regenstein adds that bones contain calcium and other nutrients not found in muscle. "Feeding them to humans is the best way to do it," he says. "I'm pro bone."

40%
Potential boost to food production from animals by using bone paste

SuperGround attempts to make bones more palatable by grinding them up, briefly exposing them to high heat and pressure, then grinding them further into a paste.

The resulting bone "mass" can be incorporated into other meat products, increasing the amount of food produced from the same number of animals by as much as 40 per cent, according to Vekkeli. Getting more meat from fewer animals would, in theory, lower environmental impacts and save money. Vekkeli says the process also uses less energy than the hours of boiling needed to make broth and leaves key nutrients intact.

But will consumers eat ground bones? In an unpublished study SuperGround conducted with more than 100 people at the University of Turku in Finland, participants reported no preference between fish balls with or without the paste, although they slightly preferred chicken nuggets containing bone paste (described as "meatier"). When *New Scientist* sampled the same fish balls used in this test, which contained 15 per cent salmon heads and bones, the snacks had a spongy consistency and a fishy flavour, but were largely indistinguishable from regular fish balls.

Vekkeli acknowledges that eating less meat would have far greater environmental benefits than simply eating more of the bones, but says gradual steps that change what the average person eats are also necessary. "It's a lot easier to use a machine than to change how people act," he says. ▮

Workers at Kalavapriikki are testing out using trout bones to make edible paste

KALAVAPRIIKKI

Analysis Cryptocurrency emissions

Should nations try to ban bitcoin because of its environmental impact?

Miners of the cryptocurrency aren't curbing its energy and water use, leading some to argue that governments should intervene, says **Matthew Sparkes**

THE amount of electricity used to mine and trade bitcoin climbed to 121 terawatt-hours in 2023, 27 per cent more than the previous year. While other cryptocurrencies have made bold changes to cut their impact, bitcoin's decentralised community of developers, miners and investors are showing little interest in changing course. If bitcoin can't clean up its own act, should governments step in?

The latest data from the University of Cambridge shows that bitcoin accounts for 0.69 per cent of all electricity consumption worldwide. It also requires vast amounts of water, both for electricity production and for data-centre cooling. A study last year found that a single bitcoin transaction uses enough water to fill a small swimming pool.

To dispense with centralised control but to ensure security and reliability, bitcoin traders register transactions in a record called the blockchain by carrying out vast numbers of calculations.

This protects the network because hackers would need to control more than half of that computer power to fake or undo a transaction. But it also sucks up resources and pumps carbon into the atmosphere. It is estimated that bitcoin accounts for 0.16 per cent of global greenhouse gas emissions.

Alex de Vries at VU Amsterdam in the Netherlands believes bitcoin's impact is indefensible. "The whole system is built to incentivise participants to waste as much resources as they can possibly afford on making computations of which the result is immediately discarded," he says.

In 2022, another cryptocurrency, Ethereum, ditched this wasteful "proof-of-work" system and replaced it with one where those who own currency control the network, rather than those who own and operate computing power. This slashed the network's energy consumption overnight by more than 99.99 per cent. More than a year on, the experiment has proved successful, and Ethereum remains secure.

VONWONG/SKULL OF SATOSHI/GREENPEACE BLOG.VONWONG.COM/SKULL

***Skull of Satoshi*, a sculpture by Benjamin Von Wong that highlights bitcoin's impact**

De Vries says the bitcoin community refuses to take the same step and remains wedded to proof of work despite its environmental impact.

"Such a system is just totally inappropriate at a time where human-induced climate change is making it more and more urgent to be more mindful about the way we use resources," he says. "We would instantly reduce global electricity consumption by half a per cent and worldwide carbon emissions by a quarter per cent [if bitcoin ditched proof of work]."

New Scientist approached several of the world's leading bitcoin mining companies for an interview on the issue. Argo, TeraWulf, Hut 8, Riot, Block Mining, Frontier Mining and HIVE Digital Technologies didn't respond. The email address of the Bitcoin Mining Council (BMC), a members' body set up to speak on behalf of mining companies, appeared to be no longer valid. A statement on the group's website says: "The BMC believes that Bitcoin's energy usage is a feature, not a bug, and provides tremendous network security."

"Without global consensus, individual bans on bitcoin are likely to lead to a game of whack-a-mole"

A campaign called Clean Up Bitcoin, backed by the US non-profit organisation Environmental Working Group and Greenpeace USA, aims to pressure the industry to reduce its environmental footprint, pointing out that the rapid turnover of machines designed to mine bitcoins also sends 30,000 tonnes of e-waste to landfill annually. The problem was highlighted last year by an art installation called the *Skull of Satoshi* (pictured), created by art activist Benjamin Von Wong.

"The growing climate and community impact of bitcoin mining is stark and heavily documented," says Erik Kojola at Greenpeace USA. "Even with this knowledge, bitcoin miners and investors continue to forge forward."

Kojola says financial firms like BlackRock, Fidelity and JPMorgan Chase are looking to push wider adoption of bitcoin by creating financial instruments that allow people to indirectly invest in it. "Our concern is that this will drive up bitcoin's price, creating an explosion in the environmental and social footprint," he says.

BlackRock says it was unable to discuss its bitcoin fund because of US Securities and Exchange Commission rules on products being reviewed. The other companies highlighted by Kojola didn't respond to a request for an interview from *New Scientist*.

If the bitcoin community or the finance industry don't work on a fix themselves, governments will need to force changes through, says Rachael Orr at the charity Climate Outreach. "It's really important that people are made aware of the environmental cost of trading in these currencies," she says. "Our research shows that people are willing to change their behaviours, but they need strong leadership from governments."

However, bitcoin's decentralised nature makes it hard to enforce change. Countries can individually ban bitcoin mining – as China did in 2021 – but without global consensus, that is likely to lead to a game of whack-a-mole where miners move to evade bans. ▮

Materials science

Bubbles could do photosynthesis

Soap films with distinct sides are a step towards copying the way plants create useful chemicals

Karmela Padavic-Callaghan

A SOAP film with one side chemically different from the other could be used for artificial photosynthesis in the future.

All other soap films and bubbles made so far have been the same on both sides, says Leif Hammarström at Uppsala University in Sweden. "We are making the first ones that are not the same."

Hammarström and his colleagues wanted to design a soap-based device for photosynthesis, the chemical reaction in which plants use sunlight to make the compounds they need to grow. But calculations and computer simulations showed that they would only be able to mimic photosynthesis if the two sides of the film were chemically different. If they were identical, the device would experience the equivalent of a battery's short circuit.

The sides of a single film don't differ naturally, so Hammarström and his colleagues had to modify the chemistry without destroying the fragile film. Methods like pipetting different chemicals on to each side were too destructive, but the researchers found that spraying different molecules on each side of the film did the trick.

In this way, they repeatedly created small samples of soap films that lasted for a few minutes at a time and had two chemically distinct sides. The molecules they sprayed respond differently to light, which helped confirm that the sides of the film were different, and they are appropriate proxies for the light-sensitive molecules required for photosynthesis (*Physical Review Letters*, in press).

In nature, plants and some bacteria use energy from sunlight to chemically process water and carbon dioxide into sugar. The soap film would similarly host chemical reactions, with water on one of its sides and carbon dioxide on the other in order to produce useful chemicals like novel fuels.

"If you want to be inspired by nature, which does photosynthesis very well, this may be a good way"

The films don't enable photosynthesis yet, but together with a prototype of a device that can keep producing many films one after another, the work is a key step towards it.

"We now have all the pieces and they are working independently. Next, we have to integrate them into one device," says team member Sylvestre Bonnet at Leiden University in the Netherlands. Soap is also cheaper and takes less energy to make than artificial photosynthesis devices that use more solid components.

Soap films like these make for a good imitation of membranes and molecules that are important for photosynthesis in nature, says Hamid Kellay at the University of Bordeaux in France. "If you want to be inspired by nature, which does [photosynthesis] very, very well, this may be a good way," he says. ▮

See page 19 for more on photosynthesis

Linguistics

AI sheds light on origins of England's place names

BY ANALYSING similarities between the names of villages and towns in England and those in a host of other places, artificial intelligence has revealed hints about their roots.

Michael Dalvean at the University of Western Australia took a list of 18,799 place names from England and 84,687 from Ireland, Scotland, Wales, Denmark, Norway, Sweden, France, Germany, the Netherlands and ancient Rome.

He then used machine learning to analyse similarities between the names in England and those from other places, comparing 263 variables, such as the pattern and location of each letter of the alphabet within the words.

Dalvean says that rather than studying language and history, as is conventionally done by place-name scholars, relying on pure statistics meant he could uncover fresh information or at least hints pointing to new avenues of research.

MIKE BOOTH/ALAMY

Places with the suffix "ton", like Widdington in Essex, are quintessentially English

After comparing the English names with those from other places, Dalvean found that Harlington is the most archetypically English and would therefore have been chosen by people who spoke the language.

This was closely followed by other places with the same "ton" suffix, such as Widdington, Beckington, Didlington and Toddington. At the other end of the spectrum, Anna was the least English of the place names in England, followed by others such as Lamanva, Laira and Lana (arXiv, doi.org/mbx7).

Dalvean concedes that some place names could originate with pre-Indo-European languages that were rarely, if ever, written down, making statistical language analysis difficult or impossible when trying to uncover the origins of these particular names. Nevertheless, he hopes his study could help point others towards fruitful avenues of research. "The first step is to work out the fundamental language, otherwise you don't know what meanings to apply," he says.

But some place-name academics are sceptical about the AI technique. Keith Briggs at the University of Oxford says that analysing the spellings of places will probably reveal little about their original names, as these will have morphed and changed over time. Thousands of years ago, place names wouldn't have been written down – possibly not until their spellings were recorded by visitors, such as tax collectors or census takers, he says.

"One of the fundamental points of place-names study is that you can't deduce anything from the modern spelling of a name," says Briggs. "The spelling changes over time and it's the spelling in the past that matters." ▮

Matthew Sparkes

Environment

Poisoned by a gold boom

People living along rivers in Bolivia have neurological symptoms and dangerously high levels of mercury because of pollution from gold mining, reports **Dan Collyns**

THE river Beni, which springs from the highlands of La Paz in Bolivia and snakes down into the Amazon basin, is the lifeblood of the Esse Ejja community. "We eat all kinds of fish, big or small, every day," says Apolinar Ocampo. "We don't have anything else to eat." But those fish are poisoning them.

Mercury is key to alluvial gold mining, a practice that is booming in Bolivia. Miners dredge up sediment, then add liquid mercury so it forms a coating around the gold particles in the silt. Later, microbes in the water and soil transform this toxic additive into methylmercury, which ends up in the bodies of fish and other animals. It passes up the food chain, becoming 10 times more concentrated at every step.

This is having a devastating impact on the Esse Ejja, whose name means "people of the river", and other riparian Indigenous peoples in northern Bolivia.

"There is a pact of silence. Miners know about it, but say nothing. They only care how much gold they get"

Oscar Campanini at the Bolivian Documentation and Information Centre and his colleagues collected 865 human hair samples from the communities living in the basins of the Beni, Madre de Dios and Mamoré rivers. Almost 90 per cent of them registered mercury levels exceeding 1 microgram per gram, the safe limit established by the World Health Organization, with some results as high as 114.4 µg/g. The data is expected to be published fully later this year.

"We knew there was a problem because of all the studies that had been carried out in various areas of these rivers," says Campanini. "But we did not imagine that the scope and intensity was so high."

ALL IMAGES BY DAN COLLYNS

Dredging for gold on the banks of the Kaka river in La Paz, Bolivia

Methylmercury causes many neurological symptoms. Esse Ejja villagers complain of aches in their bodies and heads, memory loss and confusion, as well as vomiting and diarrhoea. One man, Carlos Sosa, with a test registering 13.6 µg/g of mercury, says he can't sleep due to constant pain and uncontrollable tremors.

A study in 2021 found elevated levels of mercury in women in Brazil, Venezuela and Colombia, but the highest by far were seen in Bolivian women, averaging nearly eight times the safe limit. High levels during pregnancy can impair development in fetuses.

Ocampo, who has eight children, says they struggle to learn at school. "When the teacher says do this or that, they don't get it. My daughter is 5 years old and she barely speaks."

His wife, Cristina Torres, had mercury levels of 6.35 µg/g, more than six times the safe limit and her last child was born underweight and has anaemia.

"The problem of cognitive deficits is very severe," says Roger Carvajal at the Higher University of San Andrés in La Paz. "We presume that a whole generation of children, teenagers and young adults will have learning difficulties."

Since 2013, Bolivia has been a signatory to the Minamata Convention on Mercury, an agreement by 128 countries to curb or eliminate almost all uses of the metal, including in small-scale gold mining, and to protect vulnerable populations from contamination. But the state is doing little to mitigate the Amazon gold boom's toxic fallout.

Miners on the Kaka river (above right); Cristina Torres and Apolinar Ocampo with some of their children (right)

Between 2015 and 2019, Bolivia imported 990.9 tonnes of mercury. Imports fell from the 2019 peak to 91.66 tonnes in 2021, but this still puts it among the top five importers in the world, according to World Bank data.

It is also a hub for the resale of the metal to other countries, says Miroslava Castellón at Bolivia's vice-ministry of environment. But since June 2023, mercury imports have had to be registered and authorised by the mining ministry, she says, and there is a plan to phase out its use, although no reduction targets are set yet.

It is no coincidence that gold has become Bolivia's principal export. In 2022, the country exported 52.25 tonnes of it worth $3.2 billion, nearly eight times the amount in 2011. Powerful, unionised mining outfits called "cooperatives" account for virtually all the gold production.

"Here, there is a lot of gold, but there is also a lot of poverty," says Pablo Camacho, a doctor in Mayaya, a mining town on the Kaka river. He has seen multiple health problems in Indigenous communities, including low birth weights and babies born with missing fingers, unformed outer ears and cleft palates.

"There is a pact of silence," he says. "The miners know about it, but say nothing. They only care how many kilos of gold they get." ▮

This story was produced with support from the Rainforest Journalism Fund in partnership with the Pulitzer Center

Mental health

Psychedelic drug helps treat PTSD and traumatic brain injuries

Grace Wade

THE psychedelic substance ibogaine may treat chronic symptoms of traumatic brain injury (TBI). A single dose of the drug led to lasting improvements in physical and social functioning, cognition and mood in a group of military veterans with combat-related TBI.

"This is the first time anybody has really been able to show that there are neuro-rehabilitation effects from any psychedelic, and a pretty profound signal of improvement," says Nolan Williams at Stanford University in California.

He and his colleagues recruited 30 male US military veterans with TBI to attend a treatment facility in Mexico for five days. They were each given a dose of ibogaine, a psychedelic substance from the iboga plant native to Africa.

All the participants met a therapist before and after taking ibogaine to prepare for and to discuss their psychedelic experience. The participants could also attend activities like yoga, massage and meditation at the facility.

The veterans took a dose of ibogaine to match their weight – 12 milligrams of the drug per kilogram of body weight – and received an intravenous infusion of magnesium to help prevent cardiac problems associated with the drug.

Williams and his colleagues measured symptoms in the participants before and after treatment using a scale of 0 to 100, with higher scores indicating greater disability. At the start of the study, participants scored an average of 30, implying mild-to-moderate disability. Four to five days after the treatment, this score fell below 20 and, a month later, to around 5, indicating no disability.

At least 83 per cent of participants no longer met criteria for depression, anxiety or post-traumatic stress disorder (PTSD) a month after treatment. They also saw significant improvements in processing speed, problem solving and working memory (*Nature Medicine*, doi.org/mbwm).

But it is unclear whether the effects are due to the psychedelic drug or something else. "The big problem is [that] a lack of a control group is going to make it near impossible to say for sure what is going on here," says Albert Garcia-Romeu at Johns Hopkins University in Maryland. He says that talking with a therapist, attending wellness activities or even travelling could have contributed to these improvements.

However, a lot of these variables have previously been explored as treatments for neurological illnesses with little success, says Williams. He believes a constellation of mechanisms may explain how ibogaine could treat TBI. For instance, the drug is known to enhance neuroplasticity, or the brain's ability to rewire itself, he says. ▮

Military personnel sometimes get combat-related brain injuries

J VALENZUELA/MEDIANEWS/INLAND VALLEY DAILY BULLETIN/GETTY IMAGES

Space

Renegade moon may have flipped Venus's spin

VENUS rotates in the opposite direction to the other planets in the solar system, and astronomers aren't sure why – but it may have been caused by the drag of an ancient moon in a backwards orbit.

The early solar system was a chaotic place, with rocks hurtling around at extraordinary speeds. Valeri Makarov at the United States Naval Observatory in Washington DC and Alexey Goldin at Teza Technologies in Chicago have done a series of simulations of Venus capturing one of these rocks in orbit.

They found that it would have been easier for Venus to capture a massive moon in a backwards, or retrograde, orbit than one in a regular, forwards orbit. If Venus started out spinning in the same direction as the rest of the planets, the gravity of this hypothetical moon, nicknamed Neith, could have slowed it down and reversed its spin.

As this process continued, Neith would have smashed into any matter in the disc of material left over from Venus's formation, slowing the moon down until it ripped apart and fell onto the planet. The whole thing would probably have taken between 100,000 and 1 million years (*Universe*, doi.org/mbwk).

It could also explain why Venus has no moons now, unlike all the other planets in the solar system apart from Mercury. "A falling, massive, captured moon sweeps up and removes not only the primordial circumplanetary disc, but any other smaller satellites," says Makarov. "Neith would clear up the vicinity of Venus relatively quickly before crushing itself."

"The moon would clear up objects in the vicinity of Venus relatively quickly before crushing itself"

The hypothesis is difficult to prove, though. "Even with extensive geochemical data from Venus – a proposition that's decades away – it seems essentially impossible to test their idea," says Paul Byrne at Washington University in St. Louis, Missouri. There are other explanations, he says, like Venus colliding with a planet-sized object early in the solar system's history. ▮

Leah Crane

Mental health

Covid-19 linked to schizophrenia

Severe infections with the SARS-CoV-2 virus seem to increase risk of mental health issues

Grace Wade

PEOPLE with severe covid-19 infections are more likely to be diagnosed with schizophrenia or other psychotic disorders than those who haven't been infected. This suggests covid-19 heightens the risk of schizophrenia.

Schizophrenia is characterised by hallucinations, delusions and other cognitive impairments. It is unclear what causes it, though previous research has suggested that it may be triggered by viral infections, including covid-19 in some small studies.

To find out more, Wanhong Zheng at West Virginia University and his colleagues have analysed diagnoses of schizophrenia and similar conditions in people aged 17 to 70 who had had covid-19. They collected data on more than 650,000 people from the US National COVID Cohort Collaborative. About 219,000 participants had moderate, severe or fatal covid-19 infections, and roughly 213,000 had tested negative for the SARS-CoV-2 virus behind covid-19. The remaining participants had acute respiratory distress syndrome (ARDS), a life-threatening lung condition unrelated to covid-19. No one had a history of schizophrenia, bipolar disorder, depression, personality disorders or trauma.

"People with schizophrenia have elevated levels of kynurenic acid in their brains and spinal fluid"

The researchers examined how many participants went on to be diagnosed with schizophrenia, acute psychotic disorder or related conditions. Three weeks after infection, 2573 people had been diagnosed with a psychotic condition, about half of whom had contracted covid-19. People who had covid-19 were 4.6 times as likely to be diagnosed with a psychotic condition than those who tested negative for the virus. Those with ARDS were about 25 per cent less likely to be diagnosed with these conditions than those who tested negative.

About three months after infection, people with covid-19 were still 70 per cent more likely to be diagnosed with a psychotic disorder than people who tested negative or who had ARDS (medRxiv, doi.org/mbkh).

This is in line with the idea that having covid-19 raises the risk of psychosis, says Sophie Erhardt at the Karolinska Institute in Sweden.

One idea for why this may be is that covid-19 increases inflammation in the brain, which, in turn, leads to higher levels of a substance called kynurenic acid. Research has shown that people with schizophrenia and psychosis have elevated levels of kynurenic acid in their brains and spinal fluid, and Erhardt and her colleagues have seen similarly raised levels in those with severe covid-19. She and others hypothesise that kynurenic acid is a driver of psychosis.

"It's really important to understand the relationship between the immune system and psychiatric symptoms, including cognition, to identify new pharmacological treatments so we can help these patients," she says.

Artificial intelligence

5% chance that AI will drive humans extinct, says survey

MANY artificial intelligence researchers see the possible future development of superhuman AI as having a non-trivial chance of causing human extinction – but there is widespread disagreement and uncertainty about such risks.

The findings come from a survey of 2700 AI researchers, the largest such survey to date. It asked participants to share their thoughts on possible timelines for future AI technological milestones, as well as good or bad societal consequences. Almost 58 per cent of researchers said they considered that there is a 5 per cent chance of human extinction or other catastrophic AI-related outcomes.

"It's an important signal that most AI researchers don't find it strongly implausible that advanced AI destroys humanity," says Katja Grace at the Machine Intelligence Research Institute in California, an author of the paper. "This general belief in a non-minuscule risk is much more telling than the exact percentage risk."

There is no need to panic just yet, says Émile Torres at Case Western Reserve University in Ohio, because many AI experts "don't have a good track record" of forecasting future AI developments.

Many AI researchers now predict that AI will hit certain milestones earlier than they predicted in a 2022 version of the survey, before the launch of ChatGPT.

The development of AI that can outperform humans on every task was given a 50 per cent chance of happening by 2047, and the possibility of all jobs becoming automatable was given 50 per cent odds of occurring by 2116. These estimates are 13 and 48 years earlier than in the 2022 survey.

SARAH5/PANTHER MEDIA GMBH/ALAMY

There are fears AI could end civilisation by causing catastrophe or making robot armies

Respondents also predicted that, within the next decade, AI systems have a 50 per cent or higher chance of managing most of 39 sample tasks, including writing songs that are indistinguishable from a Taylor Swift banger or coding a payment processing site from scratch. Other tasks, such as installing electrical wiring in a new home or solving mathematics mysteries, are expected to take longer.

There are also more immediate worries, given that 70 per cent or more of participants described AI-linked scenarios involving deepfakes, manipulation of public opinion, weaponry, authoritarian control of populations and economic inequality to be of substantial or extreme concern.

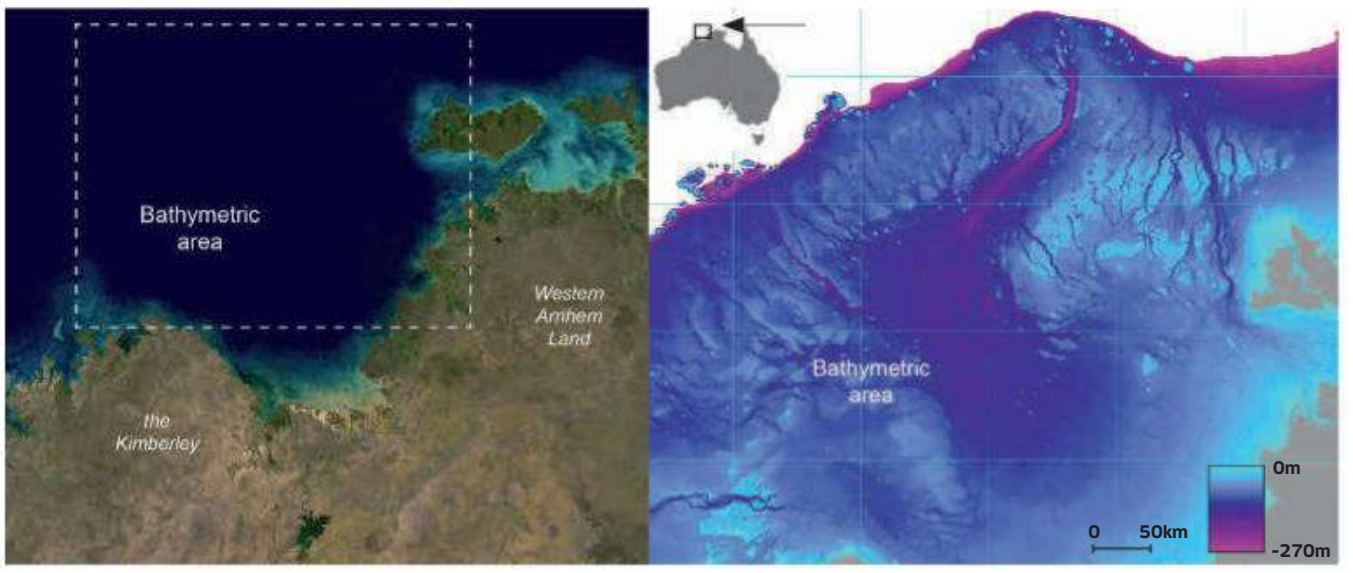
"We already have the technology, here and now, that could seriously undermine our democracy," says Torres.

Jeremy Hsu

Earth

Submerged Australian area may have hosted 500,000 people

James Woodford



KASIH NORMAN

AN AREA of land north of modern Australia that was submerged by rising seas at the end of the last glacial period could once have been home to as many as 500,000 people.

Kasih Norman at Griffith University in Brisbane, Australia, and her colleagues have reconstructed the topography of around 400,000 square kilometres of land that is now covered by the Indian Ocean, known as the Northwest Shelf.

Far from being uninhabitable, as was previously thought, the team says it was home to thriving populations of people for tens of thousands of years.

The study reveals features including an inland sea, similar in size to Turkey's Sea of Marmara, as well as a vast freshwater lake, along with gorges, rivers and escarpments like those that now exist in Kakadu National Park in the Northern Territory of Australia.

Norman says this flooded land has long been known about because of oil and gas exploration, but Geoscience Australia has recently released detailed sonar data, with each pixel representing an area of just 30 by 30 metres. "This is a high-enough resolution to be able to talk about landscape features that were important to people," she says.

The inland sea existed in a stable form between 27,000 and 17,000 years ago, the study found. A 2000-square-kilometre freshwater lake nearby was stable from 30,000 to 14,000 years ago. The lake would have been a vital refuge for people escaping the arid conditions of the Australian continent to the south.

By modelling these geographic features, the team estimates that the region could have supported a population of between 50,000 and 500,000 people (*Quaternary Science Reviews*, doi.org/mbkg).

400k
Area of the analysed region in square kilometres

14.5k
Number of years ago when seas started to rapidly rise there

4-5m
How fast the sea was rising every 100 years

Above left: satellite image covering the submerged Northwest Shelf. Above right: detailed map of the area's topography

"This massive landscape that is not there now would have been unlike anything that we have in Australia today," says Norman. "To have a freshwater lake of that size next to an inland sea is just incredible and people would have been living across it. This is a lost landscape that people were using."

But at the end of the last glacial period, sea levels began to dramatically rise. At first, the sea would have risen by about a metre every 100 years, but from 14,500 to 14,100 years ago, it rose 4 to 5 metres every 100 years, says Norman. At that rate, people would have been able to watch the sea levels rise and would have been forced to move inland to escape inundation.

The modelling of how many people this region might have supported has never been done before, says Peter Veth at the University of Western Australia, and was made possible because of the new, fine-grained palaeogeographic data available to Norman and her colleagues. ▮

Technology

Humanoid robot acts out phrases as if playing charades

Alex Wilkins

A ROBOT that can perform actions based on text prompts could pave the way for machines that behave and communicate more like us.

Large language models (LLMs) like GPT-4, the artificial intelligence behind ChatGPT, are able to write many kinds of computer code, but can struggle to do this for robot movements. This is because robots have such varied physical forms and are controlled by different software. Much of the code for this isn't on the internet, and so isn't in the training data that LLMs learn from.

Takashi Ikegami at the University of Tokyo in Japan and his team got round this by using a humanoid robot, as there is a lot of data on the human body available for LLMs. They used GPT-4 to control their Alter3 bot, which has 43 moving parts in its head, body and arms.

Ikegami and his team gave two prompts to GPT-4 to get the robot to move in response to a request.

RAITA FUTO (CC-BY 2.0)

The Alter3 humanoid robot gesturing in response to text prompts

The first asked the LLM to translate a request into a list of actions the bot had to perform to make the movement. The second got the LLM to transform each action into the Python programming language, with code mapping to body parts.

The system could come up with convincing actions for a range of requests, including "pretend to be a snake" and "take a selfie with your phone" (arXiv, doi.org/gs9km3).

Although it takes a minute or so to go from a request to Alter3 moving, Ikegami hopes such human-like motions will make our interactions with robots more meaningful. ▮

Materials science

Notoriously complex 'nightmare' substance created

Karmela Padavic-Callaghan

A STRANGE and fiendishly difficult-to-create material known as "plumber's nightmare" has been made from tiny, intertwined tubes. Although the substance itself isn't especially useful, the technique needed to produce it could be used to build other hard-to-make materials.

Plumber's nightmare consists of a pattern of six intersecting tubes, meaning that a sample contains many tubes connecting and intersecting in complex ways. The material was theorised 20 years ago and hadn't previously been made from a solid material.

Moon Jeong Park at Pohang University of Science and Technology in South Korea and her colleagues started with many long, chain-shaped molecules made from the polymers polystyrene and polyethylene oxide, which are both derived from petroleum and are similar to plastic.

They modified the ends of each chain so that they would connect to each other in new ways and assemble into shapes they don't form naturally. Some of those shapes turned out to be plumber's nightmare (*Science*, doi.org/mbnh).

Now that the team has found a recipe for making plumber's nightmare, other rare, unexpected or new polymer structures could be discovered by trying the method with different ingredients, says Glenn Fredrickson at the University of California, Santa Barbara.

An-Chang Shi at McMaster University in Canada says the team's method could also be used by synthetic chemists to create soft polymer components with any structure they may need, such as microreactors full of tiny compartments in which different chemical reactions can take place or novel containers for drugs in medicine. ▮

Palaeontology

Tiny *T. rex* fossils may be from a distinct species after all

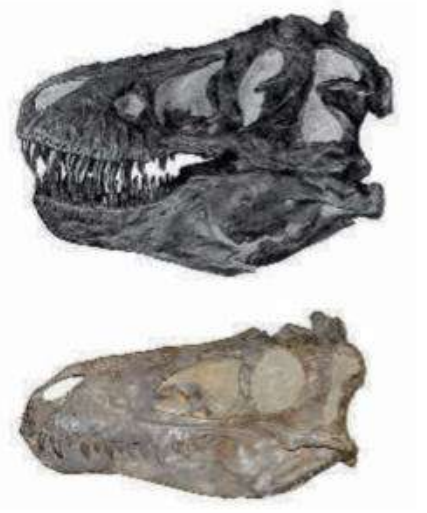
James Dinneen

TYRANNOSAURUS rex may not have been the only large carnivore reigning over North America in the late Cretaceous after all. A reinterpretation of fossils sometimes categorised as being from young *T. rex* adds weight to the idea that a smaller species, called *Nanotyrannus lancensis*, lived alongside the king of the dinosaurs.

"This is the most famous fossil animal in the world," says Nicholas Longrich at the University of Bath, UK. "There are a lot of people looking at it. And we can't agree."

The debate has divided palaeontologists for decades. A 1960s paper proposed that a skull unearthed two decades earlier in Montana's Hell Creek Formation was from a *T. rex* that had died before reaching full maturity. But in the 1980s, others argued that this fossil was in fact an adult of a distinct species, which they named *Nanotyrannus lancensis*.

More recent work based on additional fossils disputed this,



A *T. rex* skull (top) and what could be the skull of a *Nanotyrannus*

arguing that the variation between the smaller fossils and full-size *T. rex* fossils are differences of age, not species.

Now, Longrich and Evan Saitta at the University of Chicago have brought together six lines of evidence in favour of identifying the smaller fossils as *Nanotyrannus*. This included cataloguing more than 150 characteristics that differ between the controversial fossils and known *T. rex* fossils, including things like a narrower snout and smoother teeth. They argue it would be implausible for all of these to change between a juvenile and an adult.

The researchers also analysed patterns of growth rings in bones, which form as bones pause their growth each year. As an animal's growth slows, the distance between the rings shrinks. The researchers found a tightening of these rings, which they say suggests the smaller fossils are young adult *Nanotyrannus* rather than juvenile *T. rex*. They estimate that adult *Nanotyrannus* would have weighed between 1000 and 2000 kilograms, up to a quarter of an adult *T. rex*'s mass. "Any way you graph that data, you can't get that animal to turn into a *T. rex*," says Longrich.

The newest piece of evidence is a fossil bone that sits between the eye and skull, kept at the University of California Museum of Paleontology. The researchers interpret it as being from a juvenile *T. rex*. "It's an animal that's smaller than the *Nanotyrannus* but it's got the *T. rex* morphology," says Longrich (*Fossil Studies*, doi.org/mbng).

Some remain unconvinced that the controversial fossils are from a separate species. "I have no problem with *Nanotyrannus* being a real thing if science shows that," says Holly Woodward at Oklahoma State University, who authored a 2020 study of growth rings that pointed to the juvenile *T. rex* explanation. She says a specimen of a fully grown *Nanotyrannus* would be needed to resolve the matter.

"This new paper will not resolve the debate, but I am optimistic that this paper will shake things up," says Scott Persons at the College of Charleston in South Carolina. ▮

Illustration of a *Nanotyrannus* fighting a young *T. rex*

LOWER: RAUL MARTIN; UPPER: NICK LONGRICH

Space

Neptune isn't as blue as we thought it was

THE true colour of Neptune is a pale, greenish blue similar to that of Uranus, not the much deeper shade of blue most people picture.

In the 1980s, NASA's Voyager 2 spacecraft sent back photos showing that Uranus and Neptune were markedly different colours. Now, Patrick Irwin at the University of Oxford and his colleagues have reprocessed the images to show how the human eye might see the planets (*Monthly Notices of the Royal Astronomical Society*, doi.org/gtcc2d).

Voyager 2's original photos were enhanced to highlight certain features, making Neptune appear more blue. This detail was included in the initial picture captions, but Neptune's deep-blue shade later became enshrined as fact in the public consciousness, says Irwin. **Alex Wilkins**

VCG/VCG VIA GETTY IMAGES

Microbiology

Early fossil evidence for photosynthesis

PHOTOSYNTHETIC structures have been found inside fossils of cyanobacteria that are 1.75 billion years old.

Emmanuelle Javaux at the University of Liège in Belgium and her colleagues analysed fossils from rocks at the roughly 1.75-billion-year-old McDermott Formation in Australia. The researchers extracted tiny fossilised cyanobacteria, which, like plants, produce energy from sunlight via photosynthesis.

The cyanobacteria contained thylakoids, membrane-bound sacs where photosynthesis occurs. This is the oldest known evidence of these structures (*Nature*, doi.org/mbnv). The earliest fossils of cyanobacteria are about 2 billion years old, but it is believed these organisms drove the build-up of oxygen in Earth's atmosphere 2.4 billion years ago. **Grace Wade**

Technology

Most large fishing boats operate as 'dark vessels'

THREE-quarters of the world's large fishing boats and a quarter of transport and energy ships are "dark vessels" that don't publicly share their location. The finding comes from an analysis of satellite images using artificial intelligence that could help us track the impact of human activities on the oceans.

"We had an idea that we were missing a big chunk of the activity happening in the ocean, but we didn't know how much," says Fernando Paolo at Global Fishing Watch, a non-profit organisation based in Washington DC.

Paolo and his colleagues used satellite images – including radar images that can reveal objects regardless of clouds or darkness – taken between 2017 and 2021 covering the coastal regions where most large-scale fishing and other industrial activities take place. The researchers trained several AIs to detect and categorise boats within this dataset.

By comparing this global map of vessels with a database of boats that publicly broadcast their location, the researchers found that the majority weren't keeping their automated identification systems on (*Nature*, doi.org/gtb49f). Such identification isn't always required, but the lack of its use may indicate illegal fishing and other activities.

Publicly available satellite imagery lacks the resolution to detect fishing vessels less than 20 metres in length, write Konstantin Klemmer at Microsoft and Esther Rolf at Harvard University in a *Nature* article commenting on the study. But they said efforts like this can improve monitoring of activities in protected marine areas and unregulated parts of the ocean. Jeremy Hsu

Really brief

DARCY OGADA

African birds of prey under threat

Dozens of species of African birds of prey are in steep decline, with many now considered at risk of extinction. These include secretary birds (*Sagittarius serpentarius*, pictured), the population of which dropped by 85 per cent over three generations (*Nature Ecology & Evolution*, doi.org/gtcbkf).

Brain zaps make hypnotism easier

Sending electrical pulses to a specific part of the brain makes people more susceptible to hypnosis. People who received electrical stimulation of their dorsolateral prefrontal cortex, located at the front of the brain, became easier to hypnotise for up to an hour (*Nature Mental Health*, doi.org/mbn8).

Drug works against resistant bacteria

A molecule that destroys the outer membrane of certain bacteria could be effective where other antibiotics fail. In trials in mice, zosurabalpin killed antibiotic-resistant *Acinetobacter baumannii* bacteria. It is currently being tested for safety in humans (*Nature*, doi.org/mbn9; doi.org/mbpb).

Events

NewScientist

Instant Expert

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Comment

Teaching without teachers

The global shortage of science teachers should worry everyone concerned about diversity and equity in the field, says **Alom Shaha**

TEN years ago, I was asked to predict what science teaching in schools would look like in 100 years. I replied, somewhat facetiously, that it would look exactly the same as it did 100 years ago: classrooms full of children sat at desks with a teacher in front of them. Today, I would find it much more difficult to be light-hearted about such a question, because I am concerned that the way some students are being taught science is changing.

Around the world, from the US to the UK to Australia, a shortage of relevant teachers may threaten the future of science and engineering. In some places, like my home city of London, the crisis in recruitment and retention means that many students are already having lessons where there is no science teacher. Instead, they are using an online learning platform while a cover teacher watches over them.

ELAINE KNOX

I am a physics teacher; I am not against the use of technology in schools, and this isn't an article about how AI will end teaching as we know it. But there are implications for the future of science, and who gets to do it, that we should consider. An analysis of US data found that "communities that suffer the most from teacher shortages are often low-income and under-resourced". In the UK, the Sutton Trust educational charity has found the shortage of qualified science teachers results in a disproportionately large and detrimental effect on the progression rates of students from families with lower socioeconomic status. If we are concerned about diversity and equity in science, this should perturb us.

The UK's Institute of Physics told me there should be around 10,000 teachers in England with a "background and expertise" in physics, but there are only about 6500. The group blames 25 years of under-recruitment and high attrition rates and estimates there are up to 500 secondary schools (for those aged 11 to 16) in England without a single specialist physics teacher. I know of schools where the subject has been taught by PE or geography teachers whose best physics qualification was taken at age 16. Schools with the largest numbers of pupils from disadvantaged backgrounds are least likely to have teachers with relevant science qualifications.

The leader of the UK's Labour Party, Keir Starmer, has pledged that a Labour government would "tackle the retention crisis" by recruiting 6500 more teachers to subjects with shortages, such as physics. But I fear he is mistaken in his, or anybody's, ability to do this without making drastic changes to teachers' pay and working conditions.

Teaching is a demanding job with a workload many find unacceptable. It also lacks the flexibility, status and pay of some other graduate roles. In these circumstances, the use of online learning may well offer a better solution than relying on underqualified staff to teach science. The current UK government seems to think so too, funding pilot schemes of AI-powered teaching resources and work towards "providing every teacher with a personalised AI lesson-planning assistant".

While such resources are becoming more sophisticated, we should be wary of overreliance on them. We mustn't allow those with a vested interest, such as creators of online learning platforms or those making budget decisions in schools, to minimise the qualities that enthusiastic and dedicated science teachers bring to the classroom, nor the impact such teachers have on students.

Surveys consistently show that many scientists, myself included, credit their teachers as the reason they pursued a career in this field. Let's hope that, whatever happens, science education doesn't become so impoverished that it deprives future generations of the life-changing experiences that inspired many scientists before them. ▮

Alom Shaha is author of *Why Don't Things Fall Up?: And six other science lessons you missed at school*

Field notes from space-time

Stellar prospects

The past year saw developments that upend our ideas about galaxies. What a time to be an astrophysicist, says **Chanda Prescod-Weinstein**

Chanda Prescod-Weinstein is an associate professor of physics and astronomy, and a core faculty member in women's studies at the University of New Hampshire. Her most recent book is *The Disordered Cosmos: A journey into dark matter, spacetime, & dreams deferred*

Chanda's week

What I'm reading
I am listening to actor Peter Ganim read Nathan Thrall's A Day in the Life of Abed Salama: Anatomy of a Jerusalem tragedy.

What I'm watching
I absolutely loved the horror-comedy film Vicious Fun.

What I'm working on
I've been trying to teach myself some quantum optics!

This column appears monthly. Up next week: Graham Lawton

THERE were some exciting goings-on in astrophysics last year. The one that probably got the most attention was the question of whether NASA's latest flagship observatory, aka JWST or what I like to call the Just Wonderful Space Telescope, had upended what we know about the timeline of galaxy formation. The hints that there might be a problem with our understanding of how galaxies take shape came almost as soon as JWST started returning data. In 2022, the world watched as astronomers learned that galaxies seemed to form earlier, or at least faster, than expected in the early universe.

The story continued in 2023. In September, researchers led by Kasper Heintz announced they had discovered an early universe breakdown in a well-established correspondence between star formation and galactic gas metals. In astronomy, the word metals means any element more massive than helium. The team had been studying the rate at which stars formed in the early universe and the amount of metals in galaxies. There should be a clear correspondence because it is via nuclear fusion in stars that any element more massive than hydrogen or helium typically forms in the universe. The latest JWST data suggests that, in the early cosmos, the amount of metals is less than expected, based on how many stars already exist.

How this can possibly be is now a new question for astrophysicists and cosmologists to reckon with. The authors of the 2023 report propose that this indicates that galaxies in the early universe were in effect being watered down by the non-metallic gases that make up the intergalactic medium, or IGM, that surrounds them. It is possible you have never heard of the IGM before because it isn't visually exciting the way other visible matter formations are. It isn't bright like stars and it isn't a weird space-time formation like black holes. But the IGM is thought to be home to about half of the visible matter in the universe, and because it is hard to see, like dark matter – the as-yet-undetected form of matter that makes up some 85 per cent of the total mass of the universe – we have to infer a lot about it by looking at galaxies.

The IGM is quite unlike dark matter though, because it does actually radiate, and when it is backlit by X-rays coming from bright objects like galaxies with especially powerful black hole engines at their centre, we can take a look at it. There is still a lot to be learned, which is part of what makes this JWST mystery so alluring. It is possible that the low metallicity in these early galaxies is telling us something about the history and structure of the IGM and how galaxies have interacted with it over time. Thus, JWST has opened a host of new questions about star formation, galactic gases and extragalactic gases.

"Doing science doesn't lead to the end of science, but rather to more questions in need of answers"

This is a great example of how doing science doesn't lead to the end of science, but rather to more questions in need of answers. And while these are tantalising datasets, they weren't the most exciting galaxy-related result in 2023, at least not for me.

That honour goes to the Claire E. Murray-led study apparently showing that a satellite galaxy of the Milky Way, the Small Magellanic Cloud, should be thought of as composed of two distinct stellar systems superimposed on one another. My first response to this new paper on social media was: "Huge if true!" This was a bit of a joke, not only because it is the Small Magellanic Cloud and not the large one, but also because galaxies are both massive and large in spatial extent.

This result is especially exciting for me as someone who has spent the past few years trying to understand the relationship between galaxies and their dark matter halos. Studying the visible components of Milky Way satellite galaxies is one of the best ways to gain insight into this galaxy-halo relationship, since we think nearly every galaxy, even the satellites, lives inside its own dark matter halo. By looking at how stars are moving inside the galaxy, we can reverse engineer the impact that dark matter is having and in the process maybe even learn something about the fundamental nature of this matter.

As of writing, this result is so hot off the press that it has been accepted into *The Astrophysical Journal,* but has yet to be formally published there. My expectation is that there will be robust follow-up this year. There are a lot of parts to this research and scientists will want to check and recheck whether the assumptions and calculations make sense.

My prediction? In the end, this is an exciting result that will not only hold up, but also transform how we think about our galactic neighbourhood. As a member of the new Vera C. Rubin Observatory (which is set for first light in 2024 and 2025), I am keen to see if this has shifted the science we thought we were going to do. What a time to be alive and doing cosmology! ▮

Discovery Tours

NewScientist

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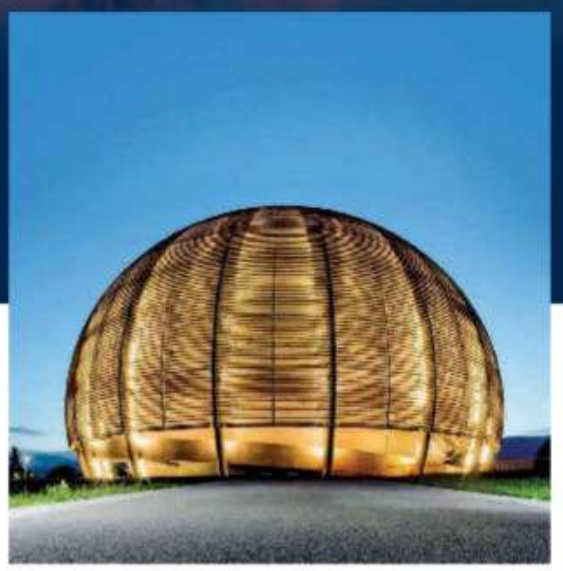
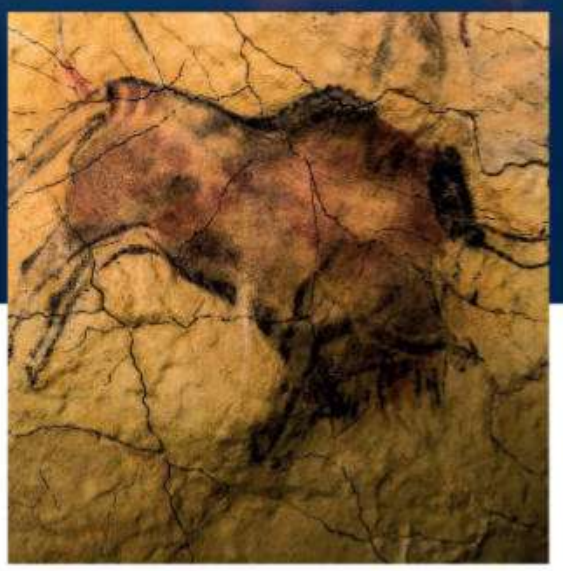


CERN and Mont Blanc: Dark and frozen matter: Switzerland and France

5 May 2024 | 6 days
8 October 2024 | 6 days

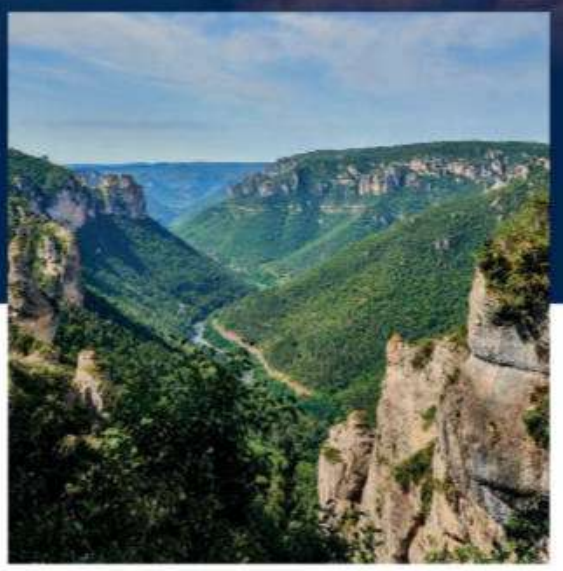
Explore Europe's particle physics centre, CERN, where researchers operate the famous Large Hadron Collider, nestled near the charming lakeside town of Geneva. Discover CERN and Geneva's fascinating histories before heading to Chamonix to explore Mont Blanc and the nearby glacier. During the tour, enjoy private lectures from particle physicist Darren Price, who will also give a personal guided tour of CERN.



Ancient caves, human origins: Northern Spain

2 June 2024 | 7 days
26 August 2024 | 7 days

Travel back 40,000 years to explore how our ancestors lived, played and worked in an idyllic part of northern Spain. Discover some of the world's oldest known cave paintings and experience the wonders of several renowned caves full of art from before the dawn of civilisation, including El Castillo, Las Monedas, La Peña Cave, El Pindal and Tito Bustillo.



Neanderthal origins and ancient caves: Southern France

8 June 2024 | 10 days
16 September 2024 | 10 days

Step back in time on a journey to the key Neanderthal and Upper Palaeolithic sites of southern France between Bordeaux and Nice with Palaeolithic archaeologist and author Rebecca Wragg Sykes. In this tour, Rebecca shows how advances in archaeological methods, especially over the past three decades, have transformed our understanding of these ancient cousins.

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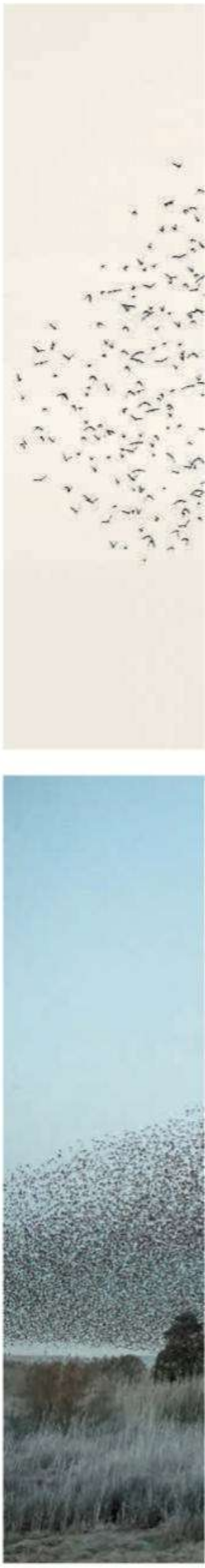

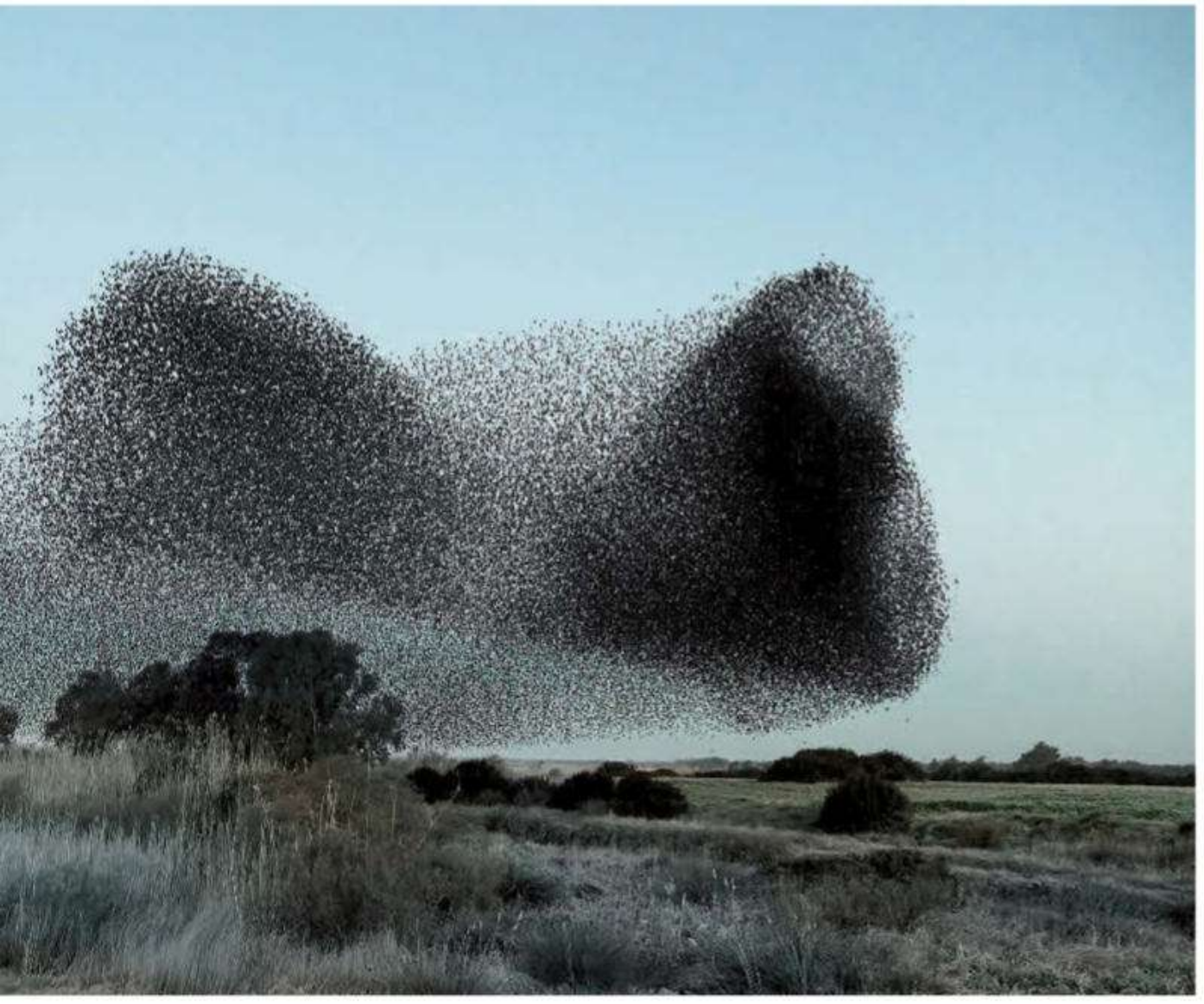

Flock together

Søren Solkær
National Nordic Museum, Seattle

THESE exquisite images show starlings swirling and swooping as one in dramatic, cloud-like flocks known as murmurations. Shot by Søren Solkær, better known for portraits of the likes of Björk and Paul McCartney, they are from a new collection of his photos.

As a child growing up in southern Denmark near the Wadden Sea, Solkær had been entranced by starling murmurations. Returning years later, he witnessed a large group of these birds being attacked by a peregrine falcon. "The shapes and formations the flock created, in order to scare off the attacking bird of prey, blew my mind – beautiful, dramatic and resembling a Japanese ink drawing or a piece of calligraphy," he says.

After three years capturing the phenomenon, known as "black sun" in Denmark, he expanded the project to other parts of Europe. At far left is *Black Sun #145*, taken above Rome's Piazza Venezia from a nearby rooftop. Moving clockwise, *Black Sun #50* was taken in Glastonbury, UK, while below it is *Black Sun #230*, photographed in Sardinia, Italy, early one morning as the birds left their roost.

"I believe that patterns in nature speak to us human beings on a deep, universal level," says Solkær. "There is joy and recognition when we experience these pure forms. To me, they seem to form a kind of language that I believe many people can relate to. Ultimately, I am hoping to inspire a deeper connection with nature – and to ourselves."

These images feature in his new book *Starling*, a sequel to *Black Sun*. Solkær's photos are on show at the National Nordic Museum, Seattle, until 10 March.

Alison Flood

Editor's pick

Surviving doomsday may be for the few

16/23 December 2023, p 60

From Tony Green, Ipswich, Suffolk, UK

I fear Stuart Clark is being over-optimistic in saying that "we" could take refuge on a gas giant's moon when our sun becomes a red giant.

Creating suitable habitation and transporting people and materials will be prohibitively expensive and it is very probable that the only people who could afford such a move would be the mega-rich. The only "ordinary" people who would be able to go would be those needed to pander to the needs of their wealthy masters.

Super elite will call the shots in our AI future

16/23 December 2023, p 56

From John Fewster, London, UK

Regarding the potential future of artificial intelligence, if there ever needs to be a ban or control on further development, who will action it? We have already seen the US, European Union and UK governments incapable of understanding, let alone controlling, simple social media.

Control reminiscent of *Nineteen Eighty-Four* is well advanced, with the masses submitting to surveillance and haplessly consuming tangible and virtual goods that they mostly don't need with money they mostly don't (yet) have. The whole scenario is in the hands of a tiny super elite. The idea that "we" have influence of any kind is sheer fantasy.

Another forgotten branch of ancient art

16/23 December 2023, p 28

From Pamela Manfield, The Narth, Monmouthshire, UK

Michael Marshall's article about forgotten art and culture from ancient times was fascinating. Even more forgotten is the input of women. They tended to work on textiles, but these rarely survive compared with metals or wood.

In August 2023, I saw a woman demonstrating weaving. She was using a bowed branch, which had grown naturally to that shape before being cut. So, before looms, people could weave using natural materials from their surroundings. Even if they survived, such wooden "looms" would, I assume, be seen as tree branches, not useful tools.

Ice wranglers, leave them icebergs alone

16/23 December 2023, p 54

From Rosemary Sharples, Sydney, Australia

Given the disappearance of ice from polar regions due to global warming, how can anyone justify towing icebergs away?

Why net zero is a sticking plaster on a mortal wound

30 December 2023, p 11

From Colin Summerhayes, Cambridge, UK

Although the COP28 summit recognised that the planet is warming due to emissions of greenhouse gases, which inevitably leads to rising sea levels, there was no recognition that the melting of snow and ice greatly reduces the reflection of solar energy back into space, known as Earth's albedo. This allows more of the sun's heat to be captured by land, sea and air, especially in polar regions, which, as a result, are warming up to four times as fast as the global average.

These regions operate as Earth's refrigerator, keeping our climate moderately cool, but because they are losing their albedo, they are experiencing a double whammy – first from global warming due to increasing greenhouse gases, then from the reduction of the albedo. We are losing Earth's refrigerator. Due to the lag between cooling and such ice reforming, it will take much more cooling than we have had of warming to regrow snow and ice cover. The net zero goal will hinder this process because taking out as much carbon dioxide from the air as we put in will maintain warming, melt more ice and snow, reduce albedo more and further weaken Earth's refrigerator.

The only way out is to cut emissions drastically. Even at the Paris Agreement's preferred warming limit of 1.5°C, ice and snow will keep melting, our refrigerator will keep shrinking and the world will keep warming. Escaping this fate will be a vast challenge. Net zero is a sticking plaster on a mortal wound.

Is carbon dioxide removal tech just a new pipe dream?

2 December 2023, p 14

From Nick Hunn, London, UK

On reading your story on negative emissions technology, it struck me that this could have been almost any article written about fusion reactors over the past 50 years, but with the words "nuclear fusion" replaced with "carbon dioxide removal". If the latter happens, it will be great, but the feeling remains that it may always be 10 years away. Promising a new game changer to policy-makers desperate for a short-term fix risks delaying the steps we need to take.

Another way of viewing family life and longevity

16/23 December 2023, p 9

From Chris Wilkins, Tewin, Hertfordshire, UK

You report that having children earlier in life is genetically linked to dying younger. Perhaps this makes more sense if we say that having children later in life is genetically linked to dying older.

Establishing a career before committing to family life is the preferred choice for some, an outlook that takes a longer view. The resulting ability to live more healthily should anticipate a longer life. Could such a mindset be reflected in our DNA?

In defence of the brain as a complex structure

Letters, 16/23 December 2023

From Chris Newton, Berkeley, Gloucestershire, UK

Tom Reimchen says we shouldn't claim the human brain is "the most complicated structure in the known universe". I agree, if it is put like that. It would seem very reasonable, however, to claim that it is "the most complicated known structure in the universe".

No easy way back from collapse of civilisation

9 December 2023, p 36

From Hillary Shaw, Newport, Shropshire, UK

Collapse of our techno-civilisation, built on fossil fuels, would have dire and permanent implications for future technology. Where will survivors find coal or tin to dig out by a pit and ladder, or oil you can drill down tens of metres to tap? Such low-hanging fruit to fuel a rebirth of advanced civilisation is long gone. There may be no further technology on this planet until geology creates new near-surface reserves, millions of years hence. Perhaps this era will be the Telopisticene: the End of Science. ▮

For the record

▮ S8 can be measured via gravitational weak lensing (16/23 December 2023, p 8).

▮ In our look at an animal milk bank (16/23 December 2023, p 58), Vlad the two-toed sloth was a faecal donor, while rhinos have a fibrous diet.

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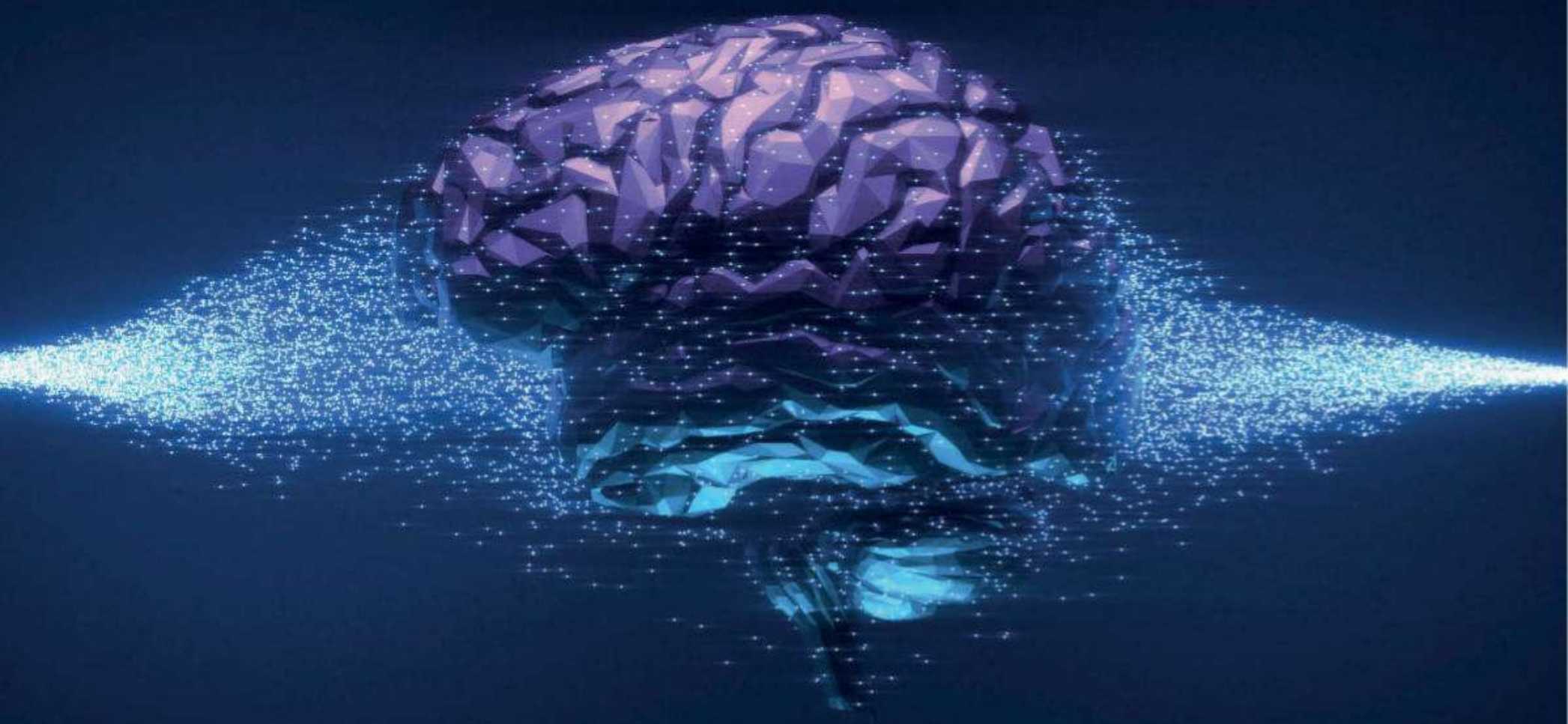

Online event

The road to conscious machines

AI from ELIZA to ChatGPT and beyond

12 March, 6 – 7pm GMT, 1 – 2pm EST and on demand

Join Michael Wooldridge, a professor of computer science at the University of Oxford and a programme director for AI, as he brings a healthy injection of humility to an overhyped field and changes the prevailing narrative on AI. He will reveal how misguided anxieties distract us from the more immediate risks that this transformative technology poses – from algorithmic bias to fake news.

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A world to save

From climate change to deforestation, a smart but controversial new book makes a strong case for optimism about Earth's fate, says **Madeleine Cuff**

Book

Not the End of the World

Hannah Ritchie

Chatto & Windus

IS THE world doomed? If you have read much of the news in recent years, you would be forgiven for thinking the planet is rushing headlong into environmental catastrophe, dragging humankind to almost certain annihilation. Reports will tell you that 2023 is set to have been the hottest year on record by a huge margin, and that the poles are melting, forests are disappearing and corals are bleaching.

But we shouldn't be consumed by despair, insists data scientist Hannah Ritchie in her first book, *Not the End of the World: How we can be the first generation to build a sustainable planet*.

Ritchie, a researcher for the Our World in Data project at the University of Oxford, has long been a go-to expert for those looking for a clear-eyed assessment of global environmental trends. In her book, she finds inspiration in the work of the late Hans Rosling, the statistician famous for TED talks highlighting progress in global development.

Like Rosling, Ritchie uses datasets spanning decades, even centuries, to communicate the truth of the world's environmental problems, how bad they are and the prospects for solving them. And she, too, argues that the situation is actually brighter than it might appear.

Not the End of the World takes seven environmental issues in turn, ranging from air pollution and climate change to overfishing and deforestation. For each, she assesses the scale of the problem and what chance we stand of fixing it. The truth, she argues, is that we are far from doomed. In fact, we know how to solve almost all of the world's most pressing environmental challenges. What's more, in many cases, change is already well under way.

LUC BEZIAT/CULTURA RM/ALAMY

Advances in green energy such as solar power show how to quit fossil fuels

"The average British citizen now has a carbon footprint equivalent to that of someone in the 1850s"

Take climate change. Global greenhouse gas emissions may still be rising, but, for the first time in history, the world has a pathway out of its reliance on fossil fuels, thanks to huge advances in clean energy and storage technologies, Ritchie writes. Similarly, air pollution could soon be a problem of the past if the world pushes forward with rolling out green electricity networks and clean cooking equipment.

With the right combination of technologies, progressive policies and behaviour change, a truly sustainable future for the planet is possible, Ritchie insists.

It is rare to find a book covering climate change with such an optimistic message, packed with feel-good nuggets of information. For example, did you know that, in the UK, per capita emissions have fallen so much that the average British citizen now has a carbon footprint equivalent to that of someone alive in the 1850s? Or that despite the media outrage surrounding ocean plastics, in fact just 0.3 per cent of global plastic waste enters the ocean each year?

The book is at its most compelling, however, when Ritchie uses her research to debunk alarmist news stories. The world's oceans won't be empty of fish by 2048, despite what headlines suggest. Nor will the planet suffocate without the "lungs" of the Amazon rainforest providing oxygen. Lazy reporting and poor science is to blame for much of the climate "doomerism" that dominates today's society, she believes.

Not the End of the World is an admirable feat, managing to transform reams of data and dense research projects into a highly readable guide to fixing the planet. Yet despite the book's optimism, there is no getting around the fact that the world still has a huge mountain to climb to avert environmental catastrophe.

Some of the power to secure a safe future lies in the hands of the average reader. In richer parts of the world, for example, most people should be eating less meat and switching to electric cars.

But eating habits aside, most of the solutions that Ritchie highlights – such as implementing a global carbon price or investing in public transport systems – rely on appropriate action from policy-makers and businesses. Given their sluggish response to date, I am not sure that I find this particularly reassuring.

In *Not the End of the World*, Ritchie has created a smart crash course on the world's environmental challenges that won't leave readers consumed by climate despair. Has it left me thinking the planet can be saved? Maybe, just maybe. ▮

New Scientist Book Club
Read Naomi Alderman's *The Future* (see right) with us
Join online at newscientist.com/sign-up/bookclub/

Earth's beautiful satellite

Intriguing facts and forgotten history mingle in what is essentially a love letter to the moon, finds **Abigail Beall**

Book
Our Moon
Rebecca Boyle
Hachette

THERE is a quote I have seen a few times recently on social media platforms. From James Baldwin's 1972 essay "No name in the street", it goes: "There is a reason, after all, that some people wish to colonize the moon, and others dance before it as an ancient friend."

The quote is about billionaires, civilisation and, of course, colonisation. And it kept springing to mind as I read Rebecca Boyle's new book, *Our Moon: A human history*. The moon, with its proximity to Earth, is the first target for any crewed space exploration beyond Earth's orbit, and humans are all ready to go back to it in the coming year (see page 41).

I don't get excited by the prospect of space colonisation – quite the opposite – but having grown up hearing stories of the Apollo era, there is something fun about being around for this second phase of crewed lunar exploration.

I have followed Boyle's science journalism for years, and after spending many evenings enjoying the wonder of the moon through my own telescope, I was excited to learn more. Her book tells all the stories you might expect: how we think the moon was made, how it exerts its impressive but complex influence on Earth, and how we first sent people to stand on it. But it also weaves in tales of Boyle's family, ancient humans and, and forgotten history – some about Boyle's own family.

"Human activity might be moving so much of the lunar surface that we are, in effect, causing a lunar Anthropocene"

For example, we meet her grandfather, Jack, who was part of a second world war mission disrupted because of a rare apogean neap tide, caused when the moon is especially far away. "The marines planned their invasion [of a Micronesian atoll] during a neap tide and couldn't understand why the tide not only failed to rise enough but did not rise at all, for almost two days," Boyle writes.

It is surprising to discover that, before the satellite era, there was no way for military planners to have known how dramatically the lunar alignment would affect the tides.

Boyle's long-standing fascination with the moon makes for an exciting read, but it also means that *Our Moon* is a great resource to dip back into after reading in its entirety.

With NASA's Artemis programme to return humans to the moon in full swing – the first crewed mission to enter lunar orbit is planned for the end of this year – this is the perfect time to reappraise the moon. And with recent evidence that human activity might be moving so much of the lunar surface about that it is causing the moon to enter a new geological period (we are, in effect, causing a lunar Anthropocene), it is vital to remember the history we share with our only natural satellite.

***Our Moon* is, on the face of it, about how we understood and set foot on this rocky world, and about our struggle to grasp its influence on Earth. But, at its heart, it is a love letter to the moon. I will watch the Artemis missions with joy and fascination. More importantly, when I next peer at our friend through my telescope, it will be with renewed appreciation. I may even dance, but that might just be to keep warm.**

Being relatively close to Earth, the moon is a natural first stop for crewed exploration

MILAMAI/GETTY IMAGES

New Scientist *recommends*

Alison Flood
Comment and culture editor
London

I have been reading Naomi Alderman's **The Future**, a sci-fi novel that I am now desperate to discuss with other people because I loved it so much.

"On the day the world ended," it begins, and then we meet tech billionaire Lenk Sketlish, who, in the middle of a meditation session intended to help him deal with his anger issues, receives an alert. It warns him that it is time to hit the prepper bunker he has been spending his fortune on.

Alderman also wrote **The Power**, a dystopian story about the fallout when teenage girls gain the ability to deliver electric jolts from their fingers. I didn't expect to finish her new book feeling hopeful about the outlook for humanity. But I did, and chose it for New Scientist Book Club. Join our 6000-plus members and read it with us (see top of page).

I have also been enjoying the TV series **Doctor Who** as Ncuti Gatwa (pictured, left) steps into the lead role. I can't wait to see where he takes the character.

JAMES PARDON/BBC STUDIOS

The games column

Playing to win This year should bring rich gaming with *Star Wars Outlaws,* wonderful surprises such as *World of Goo 2* – a satirical physics puzzle game – and, maybe, the much-delayed *Stalker 2: Heart of Chornobyl*, says **Jacob Aron**

Jacob Aron is *New Scientist*'s news editor. Follow him on Twitter @jjaron

UBISOFT

In *Star Wars Outlaws*, you play as Kay Vess, a Han Solo-like pirate

Games

Star Wars Outlaws
Massive Entertainment
PC, PlayStation 5, Xbox Series X/S

Warhammer 40,000: Space Marine 2
Saber Interactive
PC, PlayStation 5, Xbox Series X/S

Still Wakes the Deep
The Chinese Room
PC, PlayStation 5, Xbox Series X/S

Dustborn
Red Thread Games
PC, PlayStation 4 and 5, Xbox One and Series X/S

World of Goo 2
2D Boy in collaboration with Tomorrow Corporation
Platforms to be announced

Final Fantasy VII Rebirth
Square Enix
PlayStation 5

Stalker 2: Heart of Chornobyl
GSC Game World
PC, Xbox Series X/S

AS A new year begins, I am looking ahead to the biggest games of 2024. At the top of my list is *Star Wars Outlaws,* an open-world role-playing game (RPG) set in the famous galaxy far, far away. Trailers released so far suggest you will play as Kay Vess, a Han Solo-like pirate trying to get ahead while dodging both the Galactic Empire and the criminal underworld.

I am hoping that this will be everything 2023's *Starfield* wasn't, with a focus on a few planets rather than an algorithmically generated sprawl. There are some big boots to fill – the classic RPG *Star Wars: Knights of the Old Republic*, released in 2003, still triggers fond memories. With a remaster of *Star Wars: Dark Forces*, a 1995 shooter, also set for release in 2024, everything is looking good for fans of George Lucas's universe.

Speaking of nostalgia, while my days of painting plastic miniatures are definitively over, I am really looking forward to *Warhammer 40,000: Space Marine 2*. If you aren't familiar with the 40k universe, as it is known to aficionados, imagine a vision of the future where the Pope is a cyborg and everything looks like it has crawled off the cover of a 1980s heavy metal album. This game is a sequel to the 2011 shoot/hack-em-up, and I can't wait to mow down hordes of aliens.

For something a bit more cerebral, I have my eye on *Still Wakes the Deep*, a horror game set in the 1970s aboard a decrepit oil rig off the coast of Scotland. In the trailers, the sea comes across as a roiling, consuming threat, and I am intrigued to learn what the drilling has unearthed... you know it can't be good.

"In *Dustborn*, you travel across an alternate US with what appears to be a punk band in a tour bus driven by robots"

In a complete tonal shift, I would also like to know more about *Dustborn*, which explodes with comic-book colour in what I have seen so far. You play as Pax, who is travelling across a strange-looking alternate version of the US with what appears to be a punk band in a tour bus driven by robots.

One game I am extremely surprised to put on this list is *World of Goo 2*, the sequel to a charmingly satirical physics puzzle game in which you build bridges and other structures out of, well, goo. The original was released in 2008 and there had been no sign that another one would ever come out.

Elsewhere, *Final Fantasy VII Rebirth* is probably going to be a hard sell if you aren't already into video games, since it is the second game in a planned trilogy remake of 1997's acclaimed *Final Fantasy VII (*although, you don't need to have played the preceding six).

Final Fantasy VII Remake was seriously impressive, and I am expecting *Rebirth* will be one of this year's bigger games. And yes, despite the fantasy name, it does belong in *New Scientist*, because it is all about a group of self-proclaimed eco-terrorists trying to prevent an evil corporation from over-exploiting the planet's natural resources. OK, fine, there is also magic...

Finally, there is a game with the dubious honour of appearing for the third time in a row on my preview list. To be fair, the Ukrainian developers of *Stalker 2: Heart of Chornobyl*, a sci-fi survival game set in the Chernobyl exclusion zone, have a good excuse for pushing back a planned 2022 launch since their country was invaded by Russia.

The game is now slated for some time in 2024, but I wouldn't be surprised if we are still waiting this time next year. ▮

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An olive a day...

Decades of research suggest a Mediterranean way of eating carries important health benefits. We are finally starting to figure out why, finds **Michael Marshall**

WHEN it comes to healthier diets, one of them has always had a have-your-cake-and-eat-it feel. For decades, we have been told that the secret to staying well is to indulge in the delicious fresh foods of the Mediterranean. Adding more tomatoes, focaccia and olive oil to your dinner plate – and washing it down with a glass of chianti – is claimed to be a great way to reduce your odds of having a heart attack or developing type 2 diabetes.

Most surprising of all, this isn't just overhyped nonsense. Evidence has been mounting for over 50 years that the Mediterranean diet really can improve your health in many ways. "We have long-term, large clinical trials with hard clinical events as the outcomes," says Miguel Martínez-González at the University of Navarra in Pamplona, Spain.

And not many diets get a UNESCO listing. A decade ago, this United Nations body added the Mediterranean diet to its Representative List of the Intangible Cultural Heritage of Humanity.

But despite all this praise, figuring out what it is about the diet that leads to such benefits has been tricky. For starters, nutritionists can't agree on the exact form it should take. And then there are factors like eating as a family, cooking at home and other non-dietary elements that must be considered. The good news is that, over the past decade, we have begun to learn which components of the diet offer the biggest health benefits and why. This means we are closer than ever to offering the best advice on eating well, even for those who will never reside in the beautiful Mediterranean countryside themselves.

The Mediterranean diet owes its fame to US physiologist Ancel Keys and his wife Margaret, a chemist turned nutritionist. In the 1940s, Ancel became one of the first to argue that saturated fats – mostly found in animal products like meat and dairy – are a major cause of heart disease because they lead to a build-up of cholesterol in the blood. He said that unsaturated fats, which are more common in plant products and fish, are a healthier alternative.

Building on this, the couple travelled the world to study the diets people ate in different regions. The result was the Seven Countries Study, which began in 1956 and compared diet and health in parts of the US, Japan, Finland, the Netherlands, Italy, Greece and what was then Yugoslavia. The research consistently offered evidence for the link between eating unsaturated fat and a reduced risk of heart disease – a finding confirmed by other studies.

So far, so predictable. But during their work, Ancel and Margaret noticed something else. In one of their study areas – southern Italy – there

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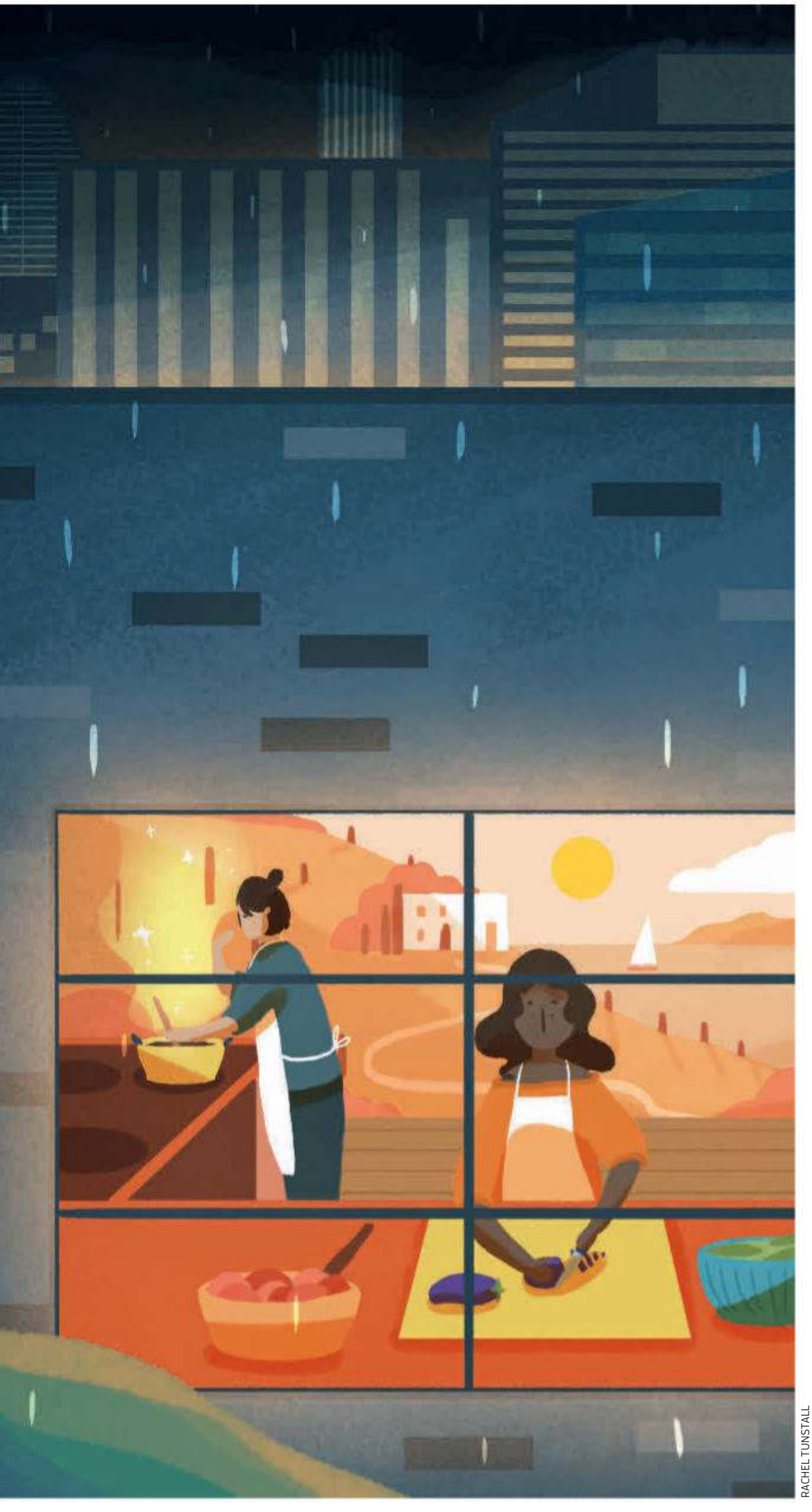

RACHEL TUNSTALL

were a surprisingly large number of centenarians. The pair became convinced that details of the local diet, which was high in unsaturated fat, were the key to this longevity. Ancel and Margaret began singing its praises, later even relocating to southern Italy to feel its benefits themselves. The fact that both of them went on to live long lives – Ancel died in 2004 at the age of 100; Margaret followed two years later, aged 97 – just seemed to add further credence to their message. The Mediterranean diet became increasingly popular.

But along the way, confusion began to arise about exactly what it comprises. One thing at least is clear: it doesn't feature large quantities of the more indulgent foods of Italy, Greece and Turkey, such as lasagne, moussaka, pizza and kofta kebabs. In fact, many people in the region don't eat the version of the diet that has been tied to health benefits.

Defining a diet

One of the most widely used definitions of what it should include is the Mediterranean Diet Score (MDS). This was developed in the 1990s by Antonia Trichopoulou, then at the National School of Public Health in Athens, Greece. An updated version was published in 2003. According to the MDS, a fully Mediterranean diet is one containing lots of vegetables, legumes, fruits and nuts, cereals and a moderately high amount of fish. It also contains little meat, poultry and dairy – and, perhaps surprisingly, it includes a moderate amount of alcohol, typically red wine.

"This is the most commonly used definition," says Martínez-González. However, he and his team developed an alternative in 2011 called the Mediterranean Diet Adherence Screener that also considers the use of olive oil in cooking (desirable) and the consumption of fizzy or sugary drinks (undesirable).

Other changes to the standard definition of the diet have accumulated over the years as researchers have continued to refine their understanding of the optimal form it should take for a prolonged healthy life. "Dairy is considered neutral now," says Richard Hoffman at the University of Hertfordshire in the UK. The amount of alcohol recommended has gone down too, he adds. But as a result of this constant tweaking and redefining, "there is no formal consensus" on the exact profile of the diet, says Martínez-González.

Even if the precise list of foodstuffs is up for debate, a series of large-scale and long-term studies have broadly confirmed Ancel and ›

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Margaret's hunch that a generalised version of it carries health benefits.

"The best evidence is for cardiovascular disease," says Hoffman. "The Mediterranean diet is generally considered to be the best dietary intervention to prevent somebody getting a heart attack or a stroke." For instance, in 2022, a study called CORDIOPREV suggested that following the Mediterranean diet rather than a generalised low-fat diet leads to a statistically significant reduction in the chances of a second cardiovascular event in people who have already had one.

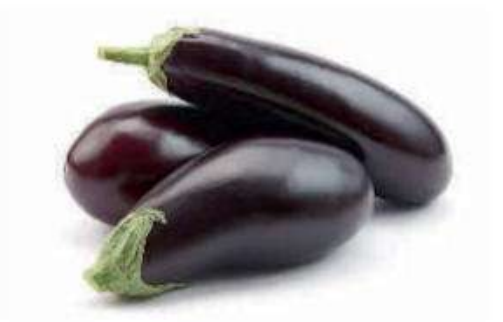
Protective properties

There is also evidence that the diet reduces the risk of developing cardiovascular disease in the first place. A 2020 review by Cochrane, a UK charity that examines evidence on health issues, looked at 22 randomised controlled trials investigating this issue and found "moderate quality evidence" that the diet reduced cardiovascular risk factors. A comprehensive overview published the following year by a pair of researchers at Harvard University found "strong evidence" that the diet protects cardiovascular health.

These protective properties are what some researchers use to explain why the mortality rate from cardiovascular disease in Italy is far below the global average: they argue that enough people in the country follow the diet to substantially affect the statistics.

The benefits seem to extend beyond cardiovascular disease. A 2020 review concluded that people who follow the diet are 20 per cent less likely to develop type 2 diabetes than those who don't. It has also been suggested that the Mediterranean diet

"The Mediterranean diet is generally considered to be the best dietary intervention to prevent a heart attack"



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reduces the risk of certain forms of cancer, including those of the breast and bladder, although more evidence is needed to confirm the link.

While some of these purported benefits may disappear as more rigorous studies are conducted, Martínez-González is confident that the diet is still worth adopting. "No study that I know has shown a harm of the Mediterranean diet," he says.

At this point, you may be preparing to dash to the shops to buy some aubergines and pine nuts, but hang on. It seems the Mediterranean diet doesn't work for everyone.

One of the biggest investigations of this way of eating is the Moli-sani study, which follows over 20,000 people who were recruited in southern Italy between 2005 and 2010. In a 2018 update, researchers led by Marialaura Bonaccio at IRCCS NEUROMED, a neurological institute in Pozzilli, Italy, found what seemed, at first, like a straightforward confirmation of an existing finding. Based on 4.3 years of data, people who followed the Mediterranean diet were less likely to experience cardiovascular health problems.

However, there was a twist. The benefits were only seen in highly educated people and those with high household incomes. "If you belong to a low-educated group or to a low-income group, this protection was not seen," says Bonaccio.

Why would people with lower household incomes or a lower educational status not get the same health benefits as wealthy and highly educated people?

One possibility is that the details of what people eat really matter, says Bonaccio. "We ask people, for example, how many fruits you eat per day," she says. But studies don't ask about the type of fruit, how it was grown or the form it took. The quality of the food, she suggests, may play a role. This would fit the data: people from lower-income households may have little choice but to buy and eat cheaper frozen or processed foods, which may not be as nutritious as fresh foods. However, finding out if this is the real explanation would require finer-grained studies of what people are eating.

With that in mind, researchers are now focusing on how specific components of the Mediterranean diet may account for its health benefits. One ingredient in particular is emerging as key: extra-virgin olive oil. "The Mediterranean diet is the diet of the countries that grow olive trees," says Bonaccio.

Olive oil producers press and grind fresh olives to release the oil, which is actually derived from the fruit, says Hoffman. This makes it unlike other oils that come from seeds and have to be extracted using chemicals and high temperatures. Extra-virgin olive oil, which tends to have a darker colour, is extracted by grinding the olives without heating them in a way that would alter the oil.

"The Mediterranean diet is far more effective if it includes extra-virgin olive oil," says Hoffman. For instance, a review published in June 2023 found that extra-virgin olive oil consumption is associated with lower blood

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The Mediterranean diet usually contains a high amount of fish

JESSICA HENRIQUE CARDOSO/GETTY IMAGES

It is possible to eat a Mediterranean diet without Mediterranean vegetables

pressure, higher levels of "good" cholesterol and lower levels of "bad" cholesterol.

The oil is rich in the unsaturated fats that were championed decades ago by Margaret and Ancel Keys. But there is growing evidence that its health benefits are partly explained by additional components that are lost if it is further processed to produce "refined" olive oil. These include a host of plant chemicals, one notable kind being polyphenols. The June review concluded that polyphenols were probably responsible for extra-virgin olive oil's benefits. In line with this, a study published in February 2023 found that polyphenols altered the gut microbiome of mice in a way that seemed to prompt the rodents to develop significantly lower blood pressure in their arteries as their hearts beat than mice that were fed a standard mouse diet or a mouse diet enriched in either butter or refined olive oil.

It isn't just the microbiome that might be implicated in the health benefits of extra-virgin olive oil. Personal genetics may play a role too, given evidence that specific nutrients in olive oil and other components of the Mediterranean diet may influence the activity of genes linked to things like inflammation. It has even been suggested that, as we learn more about this tie-up between nutrition and genetics, it may be possible to recommend specific versions of the diet for promoting health in particular people.

So where does all this leave anyone eager to benefit from the Mediterranean diet? Some researchers aren't convinced it is for everyone. They think that, as we have learned more about what is going on, it has become increasingly unclear whether the diet can be made to work beyond the Mediterranean itself. For instance, Bonaccio says we now know that each world region is characterised by distinctive features, like climate and microbes, that alter the local optimal diet. "I believe that each country should discover its own traditional diet that can protect them from diseases and help them to live longer," she says.

Vital ingredients

Others are more optimistic about the Mediterranean diet's broad applicability – although they argue that it is most important to replicate its general features rather than its specifics.

"You don't need to be eating Mediterranean vegetables like peppers and aubergines," says Hoffman. "You can be eating northern European vegetables like cabbages and carrots, and that counts just as much."

Some components, like extra-virgin olive oil, would appear non-negotiable, however: Hoffman stresses its importance. But, of course, encouraging people to buy this key ingredient is tough at a time when the cost of the oil is going up.

Martínez-González wants to see taxes introduced on ultra-processed fare like sodas and fast food, and for the revenues to be used to subsidise healthier options. The improvements to public health that better-quality diets should bring would cut the costs of medical care. "If the governments do that, they will save money at the end of the day," he says.

However, even for those who can afford to purchase high-quality foods, there is one potentially vital component of the diet that can't be found on supermarket shelves. It is possible that some of the reported benefits of the diet aren't due to the food itself, but to the associated lifestyle. Bonaccio points out that the Mediterranean villagers studied by Ancel and Margaret Keys – and later by Trichopoulou – didn't just eat a specific diet, "they also had a specific way of living". For instance, they resided in the countryside and their work was often outdoors and physical. Other studies show such factors make a difference: research published in March 2023 found that walking just an extra 500 steps a day reduces the risk of cardiovascular disease in older adults. Strength training is particularly effective at lowering this risk.

It is probably also significant that the Mediterranean villagers studied in the 20th century prepared their own food and often ate leisurely meals in social groups – which some research suggests boosts general happiness and life satisfaction, both of which are also linked to better health. "You cannot do the Mediterranean diet without cooking," says Bonaccio.

Unless we can find the time to prepare our own meals and savour them with friends, we may never feel the full effects of the Mediterranean diet. But carve out those extra hours each day for such dining, while also remaining active, and it might be possible for all of us to experience the health benefits that so impressed Ancel and Margaret on their visits to southern Italy in the 1950s. You could call it having your focaccia and eating it. ▮

Michael Marshall is a science writer based in Devon, UK, and author of *The Genesis Quest*

ALL IMAGES BY JOHN WENDLE UNLESS OTHERWISE SPECIFIED

On the trail of Africa's elusive manatees

Rumour has it that a unique group of manatees, which usually inhabit coastal waters, can be found far from the ocean in Upper Guinea. **John Wendle** joins the search

"THIS is a perfect place for manatees," says Lucy Keith-Diagne, squinting at a slow, muddy sweep of the Niandan river. It seems improbable: why would these lumbering aquatic mammals, also called sea cows, be living some 4000 kilometres up the Niger river in Guinea, almost as close to the Sahara desert as to the Atlantic Ocean? But as the world expert on African manatees, Keith-Diagne would know.

These chubby creatures are known to reside lower down the Niger river, which stretches like a giant boomerang through much of West Africa, and anecdotal evidence over the years has hinted at another population high up in tributaries near its source. What's more, Keith-Diagne believes this group has been separated from other manatees for so long that its members could be evolving into a separate subspecies. "They went up the Niger. They found good stuff. They kept going. They never came back and they became different," she says. But, for now, this is just a guess.

To find out more, we have driven hundreds of kilometres from Guinea's swampy coast, over the highlands and down into the forested savannah in search of these elusive creatures. In a two-week expedition, Keith-Diagne and her team will interview locals, chase up any leads on recent sightings and look for telltale signs of feeding along riverbanks. Crucially, they will also collect samples of river water to examine later for traces of manatee DNA. Confirmation of such an isolated population here would be a major scientific discovery. It would also be the first step in protecting these rare animals from the growing threats posed by dam construction, poaching and human encroachment.

IMAGINECHINA/SIPA US/ALAMY

A lack of infrastructure and maps makes searching for manatees in Guinea tricky, but local fishers can provide vital information

Manatees belong to an order of mammals called Sirenia, named for the old belief that they were mermaids. There are three species. The West Indian manatee is found along the south-east coast of the US, throughout most of the Caribbean and as far south as Brazil. The Amazonian manatee, classified as vulnerable, lives only in the Amazon river and its tributaries. The African manatee ranges for thousands of kilometres along the coast of West Africa, from Senegal to Angola, and is also found throughout the Senegal river and in the lower Niger river. It, too, is vulnerable, with an estimated 10,000 individuals only. Unlike its more famous American cousins, vanishingly little is known about this species.

"[Africa] is a black hole for manatee information," says Keith-Diagne, an independent US scientist who has been based in Senegal for nearly two decades. That is partly due to the animals' immense range across territory that is often inaccessible, but another problem is a dearth of local manatee experts. Keith-Diagne, who co-founded the African Aquatic Conservation Fund, is trying to remedy this by training researchers in central and West Africa. However, in Guinea, where only the coast has been surveyed, there are no manatee experts. Instead, the rest of Keith-Diagne's expedition team comprises Nyan Sangbe, a herpetologist specialising in crocodiles, snakes and turtles; Kolanga Camara, a botanist and ornithologist; Louise Haba, a geographer; and Antoine Claver Loua, a sociologist.

"The level of scientific research in Guinea has advanced in the past years, but it has been a long and difficult road," says Sangbe, who is largely self-taught. "There are no resources. There are no research centres. No research tools. Frankly, we lack everything." However, the team does have an invaluable skill: the ability to speak to villagers suspicious of outsiders in their own language. And now, after two years of planning, the researchers are finally beginning their search of an area that encompasses four high tributaries of the upper Niger: the Niandan, Milo, Sankarani and Tinkisso rivers.

Walking through a hand-tilled field carved out of the forest, Sangbe spots water through the trees. He shouts "Bingo!" and slides down a steep bank to the Niandan. Sangbe pulls a plastic water bottle out of his backpack and approaches the river's edge. "Aren't there hippos ›

and crocodiles in there?" I ask. "Yes," he says. Then he casually takes off his boots, steps in and plunges the bottle into the silty water. This sample will be analysed later for environmental DNA (eDNA), genetic material from such things as the skin and faeces that all animals leave behind in their environment. "We're at one of the furthest points that manatees could possibly come up a river in Africa," says Keith-Diagne. "And we have just collected the first eDNA water samples anywhere in West Africa for manatees."

We walk back up the slick trail from the Niandan to our trucks, which are parked at the entrance to the construction site of the Fomi dam. It is a new hydroelectric project, one of a growing number of infrastructure schemes in the region that will not only bring energy to local people, but also disruption to ecosystems and threats to local wildlife. Keith-Diagne has struggled to get details about the development from afar and is keen to see it for herself.

Here, we meet Ibrahima Condé Kebre, a local hunter. Sangbe starts chatting with him – and again, bingo! "There are manatees here during the wet season," says Condé Kebre. His sightings upriver from the dam confirm Keith-Diagne's hopes, but also her fears. "We just found manatees in a river that nobody knew they were in before. But it's also concerning because it turns out to be a river that they're never going to be able to leave," she says.

Another encounter isn't as productive. We are at a regional government office for forests and

Ibrahima Condé Kebre, a hunter in Guinea (above). Fisher N'Fali Keita has seen manatees at the mouth of the Milo river (below). Kolanga Camara and Lucy Keith-Diagne filter river water to extract eDNA (opposite page)

wildlife, a mould-covered building tucked in an electric green forest of young teak trees. A poster on the wall shows species that are protected in Guinea, including its famed chimpanzees. The sign exhorts "don't eat your brother". Manatees should be included, but they aren't. François Delamou, the office's director, says he has never seen one, or even heard of them. "When you come, it is good, because we get information about what species are protected," he says. But putting conservation into practice isn't so simple, he adds. "The problem is changing people's mentalities. People think with their bellies and not with their heads."

Although the team has drawn a blank here, other interviews confirm a local awareness of manatees – and the value of conducting on-the-ground surveys. One comes after a long day spent tracking down travel permits and speaking to officials. We cross the Niger river on a ferry made from thick planks laid over handmade canoes called pirogues to reach a village where the chief has agreed to a meeting. After an hour of chat, the questioning finally comes around to manatees. The chief and other local fishers describe sightings of a large, grey, shy animal in nearby waters. They also tell us where it hangs out.

Every day, Keith-Diagne is getting more excited about what the team is discovering. But she is well aware that the interviews are subjective and concrete evidence is required to prove that manatees live here. "That's why we have to do genetics," she says.

"How manatees swam across the Atlantic Ocean to Africa is a mystery"

When she started researching African manatees in 2006, all anyone knew was that there was a single species scattered across 21 countries. Genetic analysis of the few tissue samples Keith-Diagne has managed to collect reveals that African manatees diverged from a South American population 3 million to 5 million years ago. How the creatures, which are reliant on fresh water, swam across the Atlantic is a mystery. Her studies have also helped show that there are probably four subspecies of manatee in Africa. These include the Niger river population, of which the least is known and which Keith-Diagne thinks has long been separated from the wider African population.

Tissue samples are genetically revealing, but they are hard to obtain and export for analysis. That is why this expedition is focusing on eDNA. The new but fast-developing technique allows scientists to sample aquatic, terrestrial and aerial environments cheaply and non-invasively to confirm whether a certain species is present. "We don't ever have to touch an animal," says Keith-Diagne.

That evening, the researchers spend yet more long hours filtering water samples. On a plastic table under a tree filled with screeching fruit bats, they use a small motor to slowly pump the cloudy river water ›

A fisher poles his pirogue up the Milo river (above). Louise Haba, Nyan Sangbe and Antoine Claver Loua view the Niandan river near the construction site of the Fomi dam (left)

through a filter. The pores are small enough to catch scraps of DNA and the filters will be analysed later at a lab in the US, where researchers will look for manatee DNA. Results should be available in a few months, and Keith-Diagne eagerly anticipates them. "This might be one of the bigger discoveries of my entire career in Africa," she says.

For now, the team is thrilled with the anecdotal evidence. But even with this new information, there are few solid facts about the lives of African manatees. "So much is unknown," says Keith-Diagne. She hopes to expand our knowledge of basic information, including their range, how often they have calves, how long they raise them for and their average lifespan.

Every river is a chance to learn something new. Along the Milo, we meet a man who says he has seen manatees regularly, including a mother and calf. The fisher says the animals make deep holes in the riverbed and use them during the dry season, when water levels drop. These are his best fishing spots, he adds. He leads us to a bend in the watercourse where he says manatees congregate, and here we find a possible clue to their presence: crushed clamshells on the riverbank. This points to another peculiarity of African manatees. Although other manatee species are vegetarian, Keith-Diagne has widely documented them eating molluscs and also sucking the meat off fish trapped in fishing nets.

Where the Milo meets the Niger, the river braids and winds through a series of feathered sandbanks. Here, fisher N'Fali Keita squats, picking leaves and sticks from his casting net. Speaking to Haba, he says he has seen manatees at the nearby mouth of the Milo, but they always swim away. Two years ago, however, one got caught and died in someone else's fishing net. "It was beautiful," he says. Then, as if confirming Keith-Diagne's concerns, he adds: "The meat tastes like beef."

I am struck by how bittersweet it would be to confirm the existence of manatees in this extraordinary location – to know that they are here, but also that they face a perilous future. On the way back from another day of interviews and water sample collection, I chat with Camara and Sangbe about this. Despite the dangers from dam building and local hunters, they see deforestation as the biggest threat facing Guinea's wildlife. And they believe the only way to protect manatees is through a government campaign to raise awareness and educate people about them.

Sangbe, his usual humorous demeanour gone, says: "If nothing changes, if nothing is done, this species will disappear outright. That's it." ▮

John Wendle is a journalist and photographer based in Senegal. More of his work can be seen at johnwendle.com

‘I come to work to do cool things, like go to the moon’

KLAWE RZECZY

This year, astronaut **Christina Koch** will become the first woman to fly to the moon. She tells Leah Crane about her past adventures in space and how she is preparing for the next one

CHRISTINA KOCH has the kind of job children dream of. Beginning in 2019, on her first mission to the International Space Station (ISS), the NASA astronaut lived in space for 328 days – the longest time any woman has spent there. During that mission, she 3D printed biological tissues, grew proteins, worked on a dark matter experiment and made up half of the first all-female spacewalk.

Now, as part of the space agency’s ambitious project to send people back to the moon, Koch is getting ready for her next adventure. With it, she will cement her place in the history books. On the Artemis II mission, scheduled for November, Koch will spend 10 days on a trip to circle the moon with three other astronauts. Doing this will probably mean she won’t get to set foot on the lunar surface in the future, however, due to the lifetime safety limits on how long an astronaut can spend in space. Nevertheless, she will become the first woman to orbit Earth’s satellite and set eyes on its mysterious far side.

Artemis II will be the first crewed test of NASA’s colossal Space Launch System rocket and the Orion craft that sits atop it, setting the stage for future missions with the aim of landing humans on the moon for the first time since 1972. Koch spoke with *New Scientist* about her vital work aboard the ISS, what space smells like and the unique microgravity sports you can play in orbit.

Leah Crane: What was it like to be up there on the ISS for so long? Did you feel cooped up?
Christina Koch: I was very lucky that I got to ›

New Scientist video
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spend almost 11 months on board the ISS as my first space flight mission. I absolutely loved having that long mission – a typical mission on the ISS is around six months, and I probably would have been devastated if I had to go home after six months. I definitely wasn't ready to leave.

I never got cabin fever. It was pretty far into my mission before I realised, "I haven't felt the wind on my face in a long time, I miss that." There were definitely days where I would go over to our tiny greenhouse, which is about the size of a couple of shoe boxes, and just smell the plants. Just to smell something that was organic, that actually did a lot for me.

I've never really thought about the smell aspect – does the space station smell like anything? Body odour, maybe?
You know, if it does, we get nose blind to it very quickly. The main smell that I think most new folks notice is almost a metallic one. We sometimes say it's the smell of space. When we have a visiting cargo vehicle come and dock and we first open that hatch, there's a space in between the station and the cargo vehicle that has been exposed to just the open vacuum of space. It has this weird metallic smell.

Sometimes, right before we open the hatch, we would call everyone over to have a smell. So, luckily, we don't necessarily notice all those human smells as much, but the uniqueness of that space smell, I really will never forget.

How did it feel to break the record for the longest space flight by a woman?
A lot of people talk about this individual accomplishment of having a record. I like to think of it not so much as that, but that the milestone is important because it communicates where we are and what the state of the art is right now in human space exploration. I hope that the record I set is exceeded as quickly as possible.

I also used it as inspiration. Those days when I didn't necessarily feel up to it, I knew I had to bring my best and try to get the most out of every day because what I was doing was different from the usual ISS mission. It was an ultramarathon, not a marathon.

Doing that sort of thing is important for medical research on how long-term space flight affects women, right?
I think that I would characterise it as the long-term effects on any human, and the fact that I happen to be female could illuminate where there would be a difference. In general, anything we see that's a difference between

> "A couple of weeks before I came back, I thought, 'I should really think about what it's going to feel like to walk'"

NASA's uncrewed Artemis I launched in 2022, powered by the Space Launch System

SHUTTERSTOCK/BLUEEE77

NASA

men and women, whether on the ground or in space-flight adaptation, is an area to explore.

Is this one reason it is so important to have a diverse astronaut corps?
Absolutely. Collectively, we've made the decision that it's important to be representative of everyone that we are carrying dreams for as we explore. NASA made this decision many, many years ago, and that's why now we have an astronaut corps that represents everyone. The reason that's important is manyfold. Plenty of studies have shown that missions are more successful when you have a diverse group of people contributing to them. Not only will we discover more, get there more efficiently, learn more and be more successful because we're diverse, but we will inspire a larger segment of the population when people look at the astronaut corps.

I know that there's a lot of work to be done on the space station, but do the astronauts up there get to unwind and have a laugh sometimes too?
Human bowling is something that we do on our off time. We do have time off as astronauts: we have weekends, typically, and, of course, there is time after work. We work about 12 hours a day, five days a week, and then some extra hours on the weekend. But when we do have time off, we definitely take advantage of the fact that we are in microgravity. Human bowling is where one person kind of gets in a cannonball position and either someone throws them or they launch themselves off some handrails. Then the rest of the crew is sort of standing like the

During her 11-month stay on the International Space Station, Christina Koch did all kinds of jobs, including maintenance of spacesuits (left) and a spacewalk (below) to carry out repairs on the ISS (bottom)

pins in bowling. And the idea is that you have to, you know, bowl with your body. There has also been human surfing.

Is that just one person standing on top of another?
Yes.

After almost a year in space, was coming home super weird?
I would say super weird defines it pretty well. Coming back to Earth, standing on your own two feet, feeling the wind on your face – all those Earth things that you don't experience on board the space station. I remember a couple of weeks before I came back, I thought to myself, "I should really think about what it's going to feel like to walk". That's because I just hadn't experienced that in so long and the idea of balancing on my two feet seemed completely foreign to me.

There's the physical aspect: your body really does a great job adapting to microgravity, which means, of course, you have to readapt to gravity when you come home. There's also a huge psychological and mental aspect to coming home. I'll never forget when my head popped out of that capsule. I looked out and saw about five times as many people as I had seen in almost the last year all looking up at me and I thought, "Oh wow, I'm really happy to be home, but that's a lot of people."

Now that you are back, are you looking forward to your next mission, travelling around the moon as part of the Artemis programme?
I've been excited about it for many years, and to be a part of it as a crew member is a complete dream come true. The moon has been something that has inspired me for my whole life, really. I love gazing at the moon, I always have, and I think seeing it up close will really bring that perspective that it is a real and separate body in open space.

I can only imagine what it's going to be like to look back at Earth and see the whole thing out the window. To know that everything, every person we've ever loved, every forest I've ever walked in, is all far, far away on that one planet.

JSC/NASA

ESA/L. PARMITANO

What has the training been like so far?
It's been a lot of different things. There are a lot of people to meet. There are a lot of things to learn about, things that have been in the works for many, many, many years. So, part of what we're doing is actually a lot of travel to meet the far-flung teams – every time we meet the teams, we learn both the technical side of what they are doing and also their culture. We learn what we need to know to feel that sense of trust in the vehicle, and they learn what they need to know to see who their operators are going to be.

But then, of course, we have the real technical training, the hardcore stuff, which typically happens at the Johnson Space Center in Texas. It's been classroom work: a lot of background theoretical knowledge about the spacecraft, about the mission, about the orbital mechanics and about the science that we can do during the journey.

Now, we're moving into the phase where we get a little bit more hands-on. We're getting to play with the displays, we're getting to learn the flight software; eventually, we'll do full-length simulations with the mission control teams all over the world. And then there's the [full] hands-on stuff: there's getting in suits, getting into the vehicle, learning how we're going to get out of the vehicle if and when we need to, working with the recovery team. I think the biggest takeaway is how many people it takes to put together a mission like this and the awe of being a part of it.

Are you disappointed that you won't get to walk on the moon?
I am nothing but stoked to be a part of this mission. I am so excited that I'll get to watch some of my friends walk on the moon, that I will know those people, that I'll know the teams that got them there, that I will know the whole process that they've gone through in the Artemis programme.

I am just really excited that we are doing this, and to have a role to contribute is really just where the dream comes true for me. Every single day I wake up and come to work, I feel like I am going to work to do cool things with my friends, like go to the moon. ▮

Leah Crane is a reporter covering space for *New Scientist*

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
What are the odds of Voyager 1 or 2 hitting a star or planet? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Black hole batteries, confusing coffees and twists and turns p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Mathematics of life

All in the family

How many of us are related to Henry VIII's Master of the Mint? **Peter Rowlett** runs the genealogy calculations to find out

Peter Rowlett is a mathematics lecturer, podcaster and author based at Sheffield Hallam University in the UK. Follow him @peterrowlett

Mathematics of life reveals the mathematical ideas and shortcuts behind everyday situations. It appears monthly

IN 1540, Henry VIII's coins were made in the Tower of London. One of the Masters of the Mint was Ralph Rowlett, a goldsmith from St Albans with six children. I wondered: am I descended from Ralph? My Rowlett ancestors were Sheffield steelworkers, ever since my three-times great grandfather moved north in search of work. The trail goes cold in a line of Bedfordshire farm labourers in the 18th century, offering no evidence of a direct relationship.

My instincts as a mathematician led me to investigate this in a more mathematical way. I have two parents. They each have two parents, so I have four grandparents. So, I have eight great-grandparents, 16 great-great-grandparents and 2^n ancestors n generations ago. This exponential growth doubles each generation and takes 20 generations to reach a million ancestors.

Ralph lived 20 to 25 generations before me in an England of about 2 million people. The exponential growth argument says I have several million ancestors in his generation, so, because we run out of people otherwise, he is one of them.

But this model is based on the assumption that everyone is equally likely to reproduce with anyone else. In reality, especially at certain points in history, people were likely to reproduce with someone from the same geographic area and demographic group as themselves.

DEREK CROUCHER/ALAMY

But I am not sure this makes a huge difference here because we are dealing with something called a small-world network: most people are in highly clustered groups, tending to pair up with nearby people, but a small number are connected over greater distances. An illegitimate child of a nobleman would have a different social class to their father. A migrant seeking work could reproduce in a different geographic area.

We don't need many of these more remote connections to allow a great amount of spread around the network. This is the origin of the six degrees of separation concept – that you can link two people through a surprisingly short chain of friend-of-a-friend relationships.

I ran a simulation with 15 towns of a thousand people, where everyone has only a 5 per cent chance of moving to another town to reproduce. It took about 20 generations for everyone to be descended from a specific person in the first generation. I ran the same simulation with 15,000 people living in one town, and the spread took about 18 generations. So the 15-town structure slowed the spread, but only slightly.

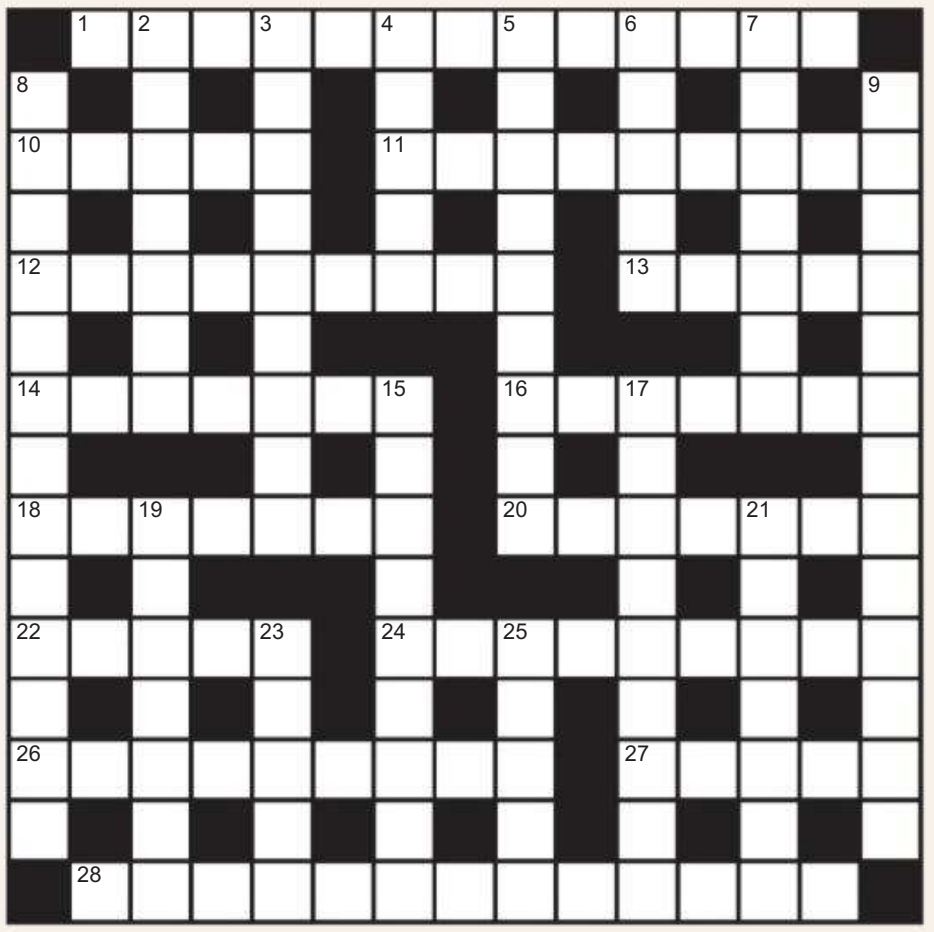
What does this mean for Ralph and me? There is a very good chance we are related, whether through Rowletts or another route. And if you have recent ancestors from England, there is a good chance you are too. ▮

These articles are posted each week at newscientist.com/maker

Next week

Debunking gardening myths

Quick crossword #149 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Apollo 11's *Columbia*, for example (7,6)
10 Rotary wings (5)
11 Inverse function to exponentiation (9)
12 Capacity; sustainability (9)
13 ___ film, thin plastic wrap (5)
14 Patterns of brain activity (2,5)
16 Superhero alter ego of Tony Stark (4,3)
18 Paperbark or honey myrtle (3,4)
20 9 Down around Earth (7)
22 Railway town in north-west England (5)
24 Female sex hormone (9)
26 Another name for an earthworm (9)
27 Protuberance at the back of the human skull (5)
28 The study of röntgen radiation coming from space (1-3,9)

DOWN

2 Point of effluence (7)
3 Spirit or Curiosity, perhaps (4,5)
4 Synthetic fabric (5)
5 Iron ore mineral (9)
6 Paul ___, English physicist (5)
7 Li (7)
8 One skilled in calculation (13)
9 The prime meridian, for example (9,4)
15 Apple co-founder (5,4)
17 Production of eggs (9)
19 16 Across, for one (7)
21 Hydrogen-3 (7)
23 Corundite (5)
25 Device such as an hourglass (5)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #234
set by Bethan Ackerley

1 The condition in which certain sounds, such as chewing or a clock ticking, trigger negative emotional or physiological responses is known as what?

2 Who first discovered extraterrestrial radio waves?

3 What is the most abundant element in Earth's crust?

4 What was the first program deliberately designed to perform automated reasoning, subsequently described as the first artificial intelligence program?

5 Lentinan is a substance derived from which species of mushroom?

Answers on page 47

BrainTwister
set by Katie Steckles
#2 Piles of money

You are given a heap of N tokens, which you may divide into any number of smaller heaps. You will then receive an amount of money equal to the product of the number of tokens in each heap. The rules of this game state that if you were to just leave all the tokens in one heap, you would win £N.

What is the largest sum of money you can win starting with six tokens?

What about starting with 10 tokens?

Is there a general best strategy for N tokens?

Solution next week

Crash course

If they continue on their current trajectories, what is the probability Voyager 1 or 2 will crash into a planet or star in the (distant) future?

Mark Thompson
Tewkesbury, Gloucestershire, UK
Both Voyager 1 and Voyager 2 have reached interstellar space. Currently, Voyager 1 is located 23 billion kilometres from Earth, while Voyager 2 has made it to a distance of 19 billion kilometres.

Since both have already passed by the planets in our solar system, they aren't expected to crash into a planet or star for some time. However, the trajectories of the probes are influenced by the gravitational forces of the stars they pass, which could cause them to change direction.

For now, Voyager 1 is moving in the general direction of the constellation Ophiuchus, while Voyager 2 is heading towards Sagittarius. Still, the vast distances between stars mean the probes are unlikely to approach any specific star system for tens of thousands of years.

"Voyager 1 is moving in the general direction of the constellation Ophiuchus, while Voyager 2 is heading towards Sagittarius"

Both Voyager 1 and Voyager 2 are powered by radioisotope thermoelectric generators, which convert the heat generated by the decay of plutonium-238 into electricity. These are expected to provide enough power to keep the Voyagers' instruments running until around 2025. After that, the probes will no longer be able to communicate with Earth, but they will continue to travel through space.

Luce Gilmore
Cambridge, UK
The chances of collision between a space probe and a macroscopic obstacle in interstellar space are vanishingly small.

That includes entire solar systems. Our solar system is about 60 astronomical units (AU) in diameter (up to Neptune) and the nearest star system, Alpha Centauri, is about 270,000 AU away. This means that, at the distance of Alpha Centauri, our solar system would occupy only three-billionths of the surface area of a sphere of that radius – quite a small target. If a probe did pass through a star system, it would almost certainly trace a hyperbolic orbit and exit unscathed, as did the extrasolar asteroid 'Oumuamua.

However, macroscopic obstacles aren't the only sort in interstellar space: there are cosmic ray particles too. In any volume of space, the energy density due to starlight is only twice that of cosmic rays, so they are relatively abundant.

Cosmic ray particles are energetic and when they hit a solid object, they will knock an atom sufficiently hard that it generates a cascade of secondary impacts. In a structure as small as a typical space probe, this will result in a shower of atoms ejected into space at high speed. This amounts to stochastic "spallation" that will, given sufficient time, abrade any probe to nothing. Such is the fate of the five probes that are bound for the stars so far.

Damir Blazina
Chester, UK
Both Voyagers will eventually collide with something, most likely the remnants of a star, but this will take an extraordinarily long time.

The Voyagers' highest chances of collision were in the solar system, around the planets and in the asteroid and Kuiper belts, which they have already safely traversed. Their trajectories were carefully planned to maximise the chances of safe passage.

The next highest chance of collision will occur in some 300 years, when both spacecraft are expected to enter the Oort cloud, a hypothesised cloud of icy planetesimals surrounding the sun at distances of around 2000 to 200,000 times that between the sun and Earth. The Oort cloud constitutes trillions of objects and the traverse will take some 30,000 years, but models suggest that the objects there are a few hundred metres to a few kilometres in size and are separated by millions of kilometres. The probes are most likely to sail though untouched.

Afterwards, the probes will be in empty space, where there is nothing to collide with. For a collision to occur, they would need to come close enough to a star and approach at the right velocity to be drawn towards it by gravity, after which they could collide with the star itself or with one of its orbiting planets or other bodies. Considering that star systems are usually separated by several light years, this is extremely unlikely.

Calculations in a 2019 paper from Coryn Bailer-Jones and Davide Farnocchia indicate that in the next 11 million years, Voyager 1's closest approach to another star will be at a distance of around 0.3 parsecs and a relative speed of 46 kilometres per second, while Voyager 2 will come no closer than 0.5 parsecs at a relative speed of over 70 km/s. (A parsec is some 31 trillion kilometres). This is too far and too fast to be significantly affected by the stars' gravitational fields, so the probes won't collide.

However, the spacecraft lack

LINDA BUREK/ALAMY

This week's new questions

Crowing about it **How do crows develop such distinct and individual "voices"? I don't hear this with other bird species in my garden.** ***Jill Colman****, Peterborough, Cambridgeshire, UK*

Tempus fugit **Why do older people seem to experience time passing more quickly?** ***Derek Johnson****, Moreton-in-Marsh, Gloucestershire, UK*

Why do crows have such distinctive and individual voices, compared with other birds?

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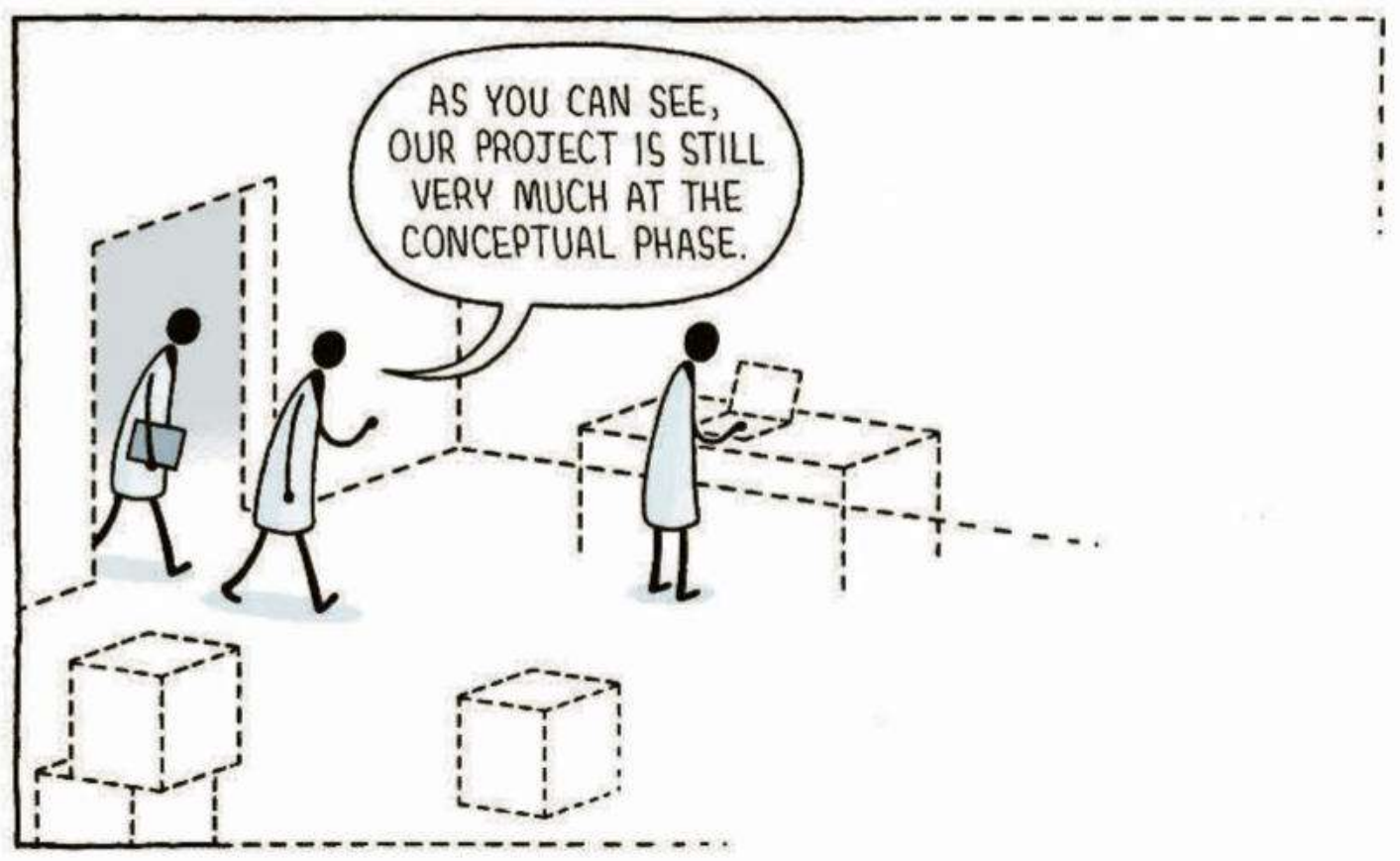
Tom Gauld
for New Scientist



the velocity to escape the galaxy, meaning they will eventually pass close enough to some star to be drawn towards it. The same paper estimates that the timescale for one of them to collide with a star is in the order of 10^{20} years. This is six orders of magnitude longer than the time by which all stars in the universe will have exhausted their fuel, so the collision will be with a stellar remnant such as a white dwarf or a black hole.

Suck it up

Why does a slightly damp sponge absorb water so much better than the same sponge when it is bone dry?

Chris Daniel
Colwyn Bay, Conwy, UK
Sponges for dish washing can be made of polyester, which has mechanical properties that make it useful as a cleaning material, as well as being soft to handle when dry or wet. However, the polymer is hydrophobic, or water-repellent, which means its surface energy is

"A detergent reduces the surface tension of the water, making it more compatible with the low surface energy of a sponge"

lower than the surface energy, or surface tension, of water.

A dry sponge will therefore tend to float when placed on water, only absorbing liquid gradually. It can be forcibly wet by being submerged, compressed and released so that water fills its open-cell structure. When the bulk of the water is squeezed out, there will be sufficient remaining water in the sponge for the internal surfaces to be almost perfectly hydrophilic, allowing water to enter and fill the sponge again.

When washing dishes, a detergent is usually added to reduce the surface tension of the water, making it more compatible with the low surface energy of a sponge, in addition to its primary purpose of helping to remove fats from surfaces.

Mark Dirnhuber
Bristol, UK
This phenomenon applies to cellulose sponges.

Cellulose is a polymer of glucose and owes its strength to extensive hydrogen bonding between numerous hydroxyl groups, holding the glucose chains tightly side by side. These also give it great affinity for water, so cellulose surfaces are very wettable because this attraction is even stronger than that between the water molecules themselves. This results in the wet cellulose sucking up the water into the pores by capillary action.

Dry cellulose will first need to be wet for this to happen, and there are energy barriers to be overcome, notably due to the surface tension of the water itself. Because the cellulose surface is rough, a water droplet might sit there for a while as a bead before the wetting takes place. Cellulose also absorbs some water into (not just onto) its structure, which will divert water from the surface and further slow the wetting. ▮

Answers

Quick quiz #234 *Answers*

1 Misophonia
2 Karl Jansky
3 Oxygen
4 Logic Theorist
5 The shiitake (*Lentinula edodes*)

Cryptic crossword #126 *Answers*

ACROSS 7 Thiamine, **8** Mute, **9** Denial, **10** Floury, **11** Spay, **13** Shivered, **15** Roughs it, **17** Wink, **18** Silica, **20** Gasket, **22** Zinc, **23** Chatbots

DOWN 1 Ghee, **2** Ratify, **3** Violists, **4** Leaf, **5** Impose, **6** Sturgeon, **12** Prolific, **14** Integral, **16** Glitch, **17** Wasabi, **19** Arch, **21** Efts

#1 Digital sevens *Solution*

106 is the next number after 95.

Two consecutive numbers would need to end in 9 and 0 to have their digit sum differ by 0 or a multiple of 7, and the smallest example is 69999, which has digits that add up to 42 (a multiple of 7), and 70000, which has a digit sum of 7.

For numbers two apart, the only pairs under 100 are (59, 61) and (68, 70).

Tiny black hole batteries

Following on from Feedback's discussion about the Black Hole public toilet in New Zealand (25 November 2023) comes word of a plan called "Using black holes as rechargeable batteries and nuclear reactors", published in the journal *Physical Review D*.

Successful technologists, almost as much as unsuccessful technologists, are not so easily cowed by limits others believe to be insurmountable. The plan's authors, Zhan-Feng Mai and Run-Qiu Yang at Tianjin University, China, keep their chins up and their minds cranking.

They write: "Though the black hole's strong gravity forbids that the classical matters escape from it into outside, fortunately, the energy can be extracted from the black hole through quantum or classical processes."

They handwave away the swath of problems reputed to afflict anyone who suggests even going near a black hole. Their black hole, they specify, will be a "tiny black hole".

This kind of confidence inspires venture capitalists, a variety of humans who are experiencing a golden age here in the early 2020s. Many are looking for new big opportunities to raise funds and invest portions thereof after extracting appropriate fractions therefrom.

Black hole batteries could be their next big thing, following hard on the flighty footsteps of cryptocurrency and artificial intelligence, both of which flocks of investors have found to be as compellingly attractive as black holes.

Two-story superpower

Alison Litherland tells of a beneficially duplicitous trivial superpower.

She says: "Your mention of Rosemary Firman's husband's ability to read two different pages of braille at the same time (16 September 2023) reminded me of the trivial superpower I had when my children were little.

"I could read them a bedtime story out loud while at the same time silently reading a novel to myself. I have no idea how my brain managed to separate out the two stories, but it certainly helped with the tedium of reading the same bedtime story yet again."

Twisteddoodles *for New Scientist*

Got a story for Feedback?

Send it to feedback@newscientist.com
or New Scientist, 9 Derry Street, London, W8 5HY
Consideration of items sent in the post will be delayed

Coffee with confusion

Ambiguity has a field day in this medical journal headline: "Coffee and heart failure: A further potential beneficial effect of coffee".

That title rides atop a letter to the editor from Anna Vittoria Mattioli and Alberto Farinetti at the University of Modena and Reggio Emilia in Italy. The journal is *Nutrition, Metabolism and Cardiovascular Diseases*.

Mattioli and Farinetti explore some of the ambiguities in medical investigations – and medical pronouncements – about good and bad health effects of drinking coffee.

Some people in some places drink espresso, some drink other forms of coffee. Some drink filtered coffee, some unfiltered.

Some people in some places drink coffee "in relation to a meal, thus influencing absorption and effect on the gut", some drink it standalone. Some people are men, others are not, with possible differences in "the absorption of macro and micro nutrients and in their bioavailability".

Further studies, Mattioli and Farinetti suggest beneath their confusion-inducing headline, are required to "not create confusion".

Edge on edge

Sam Edge is vexed about a paper that featured in a previous Feedback column (4 November 2023) called "New insights on the genetics of hair whorls from twins and the southern hemisphere". Sam finds it hair-raising that the paper drew any attention.

He says: "The old chestnut about drain circulation rears its head again, I see. Given the tiny volume and mass involved in a head of hair, coupled with the fact that people spend a significant amount of their time in a non-vertical pose and moving around, it's ridiculous to suggest that the Coriolis force could be involved in hair whorling." The Coriolis force, you will recall, is a surprising twist in how things appear to move while something rotates.

Feedback hopes it won't set Edge on edge to learn that there is a new version of that paper. Now titled "Genetic determinism and hemispheric influence in hair whorl formation", it appears in the *Journal of Stomatology, Oral and Maxillofacial Surgery*.

The new version gives a twisty, this time distanced, nod to the Coriolis question: "Other non-hemispheric factors should [be] assessed on samples from various Northern and Southern hemisphere locations, such as maternal health, maternal nutrition, and/or prenatal hormone exposure, before considering a potential effect of hemispheric environmental physical factors such as the Coriolis force."

Sheffield names harvest

Susan Frank doesn't beat about the bush in conveying garden variety information.

She writes: "I thought you'd like the names of two of our trustees associated with the Sheffield Botanical Gardens Trust, Barbara Plant and Christine Rose."

Feedback notes that the Sheffield Botanical Gardens Trust website clarifies (by displaying the info specially within parentheses) that trustee Miles Stevenson, who is neither a plant nor a rose, is a chair. ▮

Marc Abrahams

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